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ON THE LEPIDOPTERA

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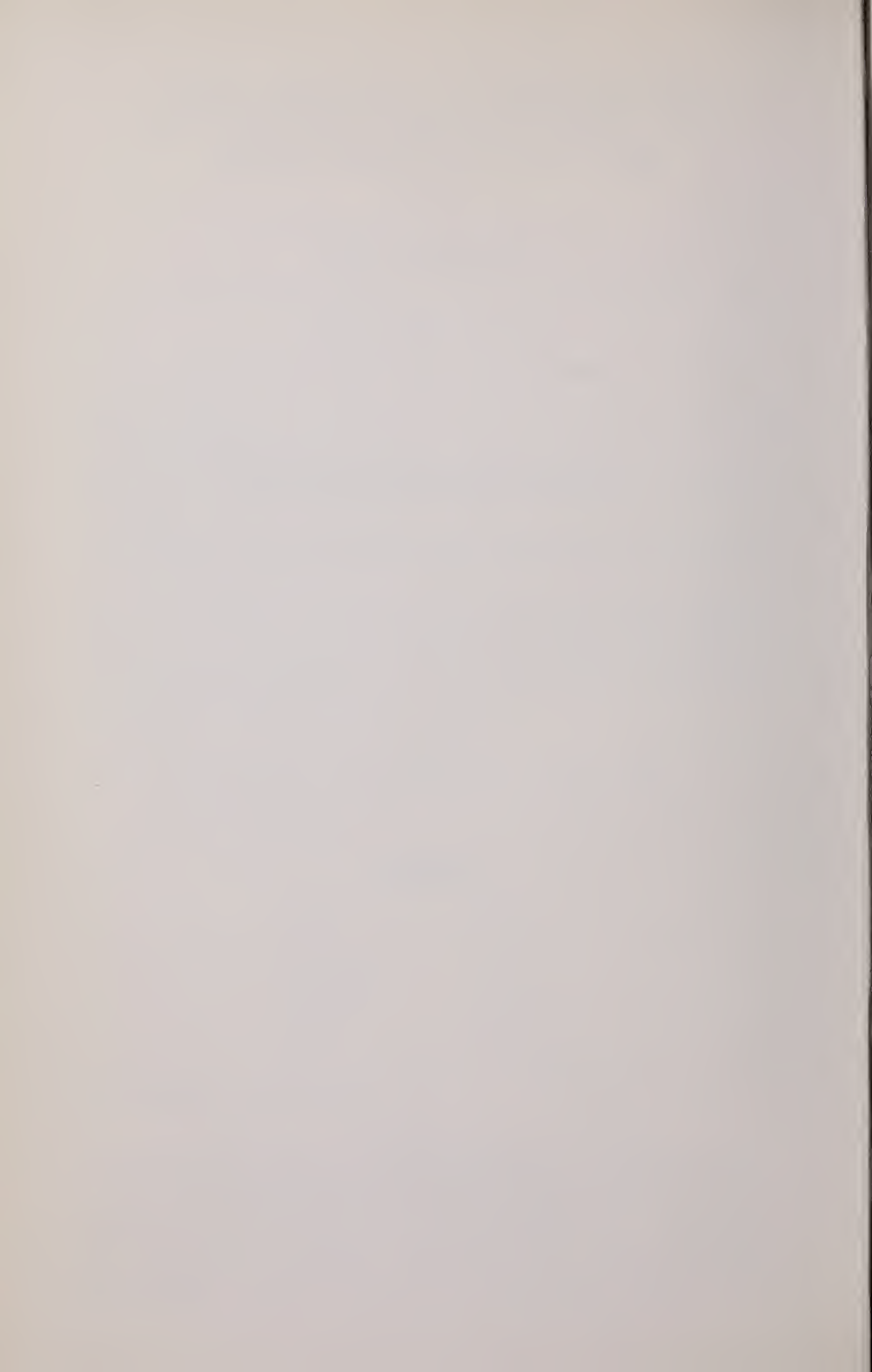
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A PROPOSED REVISION OF NON-ARCTIC  
*PARNASSIUS PHOEBUS* FABRICIUS  
IN NORTH AMERICA (PAPILIONIDAE)<sup>1</sup>

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THE SUBSPECIES OF *Parnassius phoebus* Fabricius in North America have been in a state of confusion for a number of years. This is, in part, a result of the papers published by Bryk and Eisner in the 1930's and later by Eisner in the 1950's and 1960's. McDunnough, 1936a, b took exception to some of their work, but most of the Bryk and Eisner taxa persist. Additional names have been proposed by Bang-Haas and Wyatt. Other workers who have contributed to the nomenclature in this species include Doubleday, H. and W. H. Edwards, Holland, Neumoegen, Stichel, Wright, and several others whose taxa were sunk into synonymy by dos Passos in 1964. If forms are counted, then there are forty-four names recognized by dos Passos. Four additional subspecies and several form names have been proposed since completion and publication of the dos Passos checklist. Of these more than fifty names, five apply to arctic races and the remainder apply to populations associated with southwestern Canada and the western United States. In addition, Bryk and Eisner have published a number of infraspecific names not recognized by dos Passos.

At this point, one must examine taxonomic philosophy. There are "lumpers" (everything is *Parnassius phoebus*), "middle-of-the-roaders" (there are some valid subspecies), and "splitters" (specimen A has a spot that specimen B lacks, thus they are nomenclaturally distinct). Our European colleagues tend to be "splitters" to a greater degree than workers in the U.S. and have carried this process to extremes in some instances. Eisner, 1955b, cites ten "aberrational" names to be applied to both wings in *Parnassius*, twenty-seven such names to be applied to FW vari-

<sup>1</sup>Published with the approval of the Director, Wyoming Agricultural Experiment Station as Journal Article no. JA 835.

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ations, and thirty names for HW variants. These apply to ground color, marginal fascia, spot size, color of spots, etc. and are applied singly or in combination, e.g. *Parnassius phoebus sayii* form *magna* + *quadropicta* + *albopicta* + *rubroocellata*. The latter translates as a specimen of *P. ph. sayii* which is especially large, with four red costal spots on the FW that have white centers, and red spots on the HW. Another specimen from the same colony might not be designated "*albopicta*" since its FW spots are uniformly red. The foregoing is not intended to belittle any workers, but to indicate the extremes to which nomenclature can be carried; such combinations are found frequently in the Bryk and Eisner literature.

Workers in this country tend to recognize variations within a given species as originating from environmental factors, geographic isolation, genetic variation, etc. Within given colonies of a butterfly species, there can be variations based upon the gene pool, and in multivoltine species, frequent seasonal variations. Blend zones or tension zones are recognized in areas where populations or races overlap. When a strong character, or a group of lesser but consistent characters is recognized which reliably separate groups within a species, then subspecies may be designated. This is the general philosophy espoused by the I.C.Z.N., but the categorization stops at this point. Intraspecific names (forms, aberrations, etc.) are not recognized. In view of the variability of biological entities, this seems a wise policy.

With regard to the above introduction, the intent of this paper is to attempt a rational taxonomic review of *Parnassius phoebus*, with particular regard to the Rocky Mountains. Insufficient study material is available to review the arctic subspecies in detail. Several of these taxa are known only from type series housed in European museums. All are perhaps valid taxa as a consequence of extreme geographic isolation. For completeness, they are listed with their authors, dates, and type localities. The other available taxa are listed according to geographic region, in chronologic order and by page priority. One should refer to dos Passos, 1964, for synonymy.

#### Arctic Subspecies

*apricatus* Stichel, 1906. Kodiak Island, Alaska.

*golovinus* Holland, 1930. Golovin Bay, Alaska.

*elias* Bryk, 1934. St. Ilya, Alaska.

*alaskaensis* Eisner, 1957. McKinley National Park, Alaska.

*yukonensis* Eisner, 1969. Haines Junction, Yukon Territory, Canada.

West Coast (California and the Pacific Northwest)

*behrii* Edwards, 1870. Fixed by Brown, 1975, as near the summit of Mt. Lyell, Yosemite Valley, California.

*magnus* Wright, 1905. Enderby, British Columbia, Canada.

*sternitzkyi* McDunnough, 1936 [1936c in Lit. Cited.] Castle Lake, Siskiyou Co., California.

*olympianus* Burdick, 1941. Hurricane Ridge, Olympic Range, Clallam Co., Washington.

*guppyi* Wyatt, 1969. Mt. Arrowsmith, Vancouver Island, British Columbia, Canada.

#### Great Basin

*hollandi* Bryk and Eisner, 1935. La Sal Mountains, Utah.

*rubina* Wyatt, 1961. Liberty Peak 3120 m., Angel Lake 2900 m., Ruby Mountains, Elko Co., Nevada. [Actually, Angel Lake is in the East Humboldt Range.]

#### Rocky Mountains

*smintheus* Doubleday, 1847. Nr. Laggan (Lake Louise) and Banff, Alberta, Canada.

*sayii* Edwards, 1863. Fixed by Brown, 1975, as Running Creek Field Station, 6950' (2118 m.), Elbert Co., Colorado [T9S, R65W, SW 1/2 25 Native.]

*hermodur* H. Edwards, 1881. Gilpin or Boulder Co., Colorado, [Brown et al., 1957.]

*nanus* Neumoegen, 1890. Fort Calgarry and Spence's Bridge, British Columbia, Canada. [Calgary, Alberta and Spence's Bridge, British Columbia.]

*xanthus* Ehrmann, 1918. Moron, Idaho. [Actually Moscow, Latah Co., Idaho; see Avinoff in Holland, 1927.]

*montanulus* Bryk and Eisner, 1935. Turah, Missoula Co. and Kiowa, Glacier Co., Montana.

*dakotaensis* Bryk and Eisner, 1935. Mt. Roosevelt, Black Hills, South Dakota. [Mt. Theo. Roosevelt, Roosevelt Monument, T5N, R3E, S16, Lawrence Co., South Dakota.]

*maximus* Bryk and Eisner, 1937. Judith Mountains, Montana.

*rotgeri* Bang-Haas, 1938. Mt. Evans, Clear Creek Co., Colorado.

*pseudorotgeri* Eisner, 1966. Elwood Pass, Rio Grande Co., Colorado.

Based upon the marginal scaling of the forewings of the males, the North American *Parnassius phoebus* can be divided into two groups: the *smintheus* group and the *behrii* group. This char-

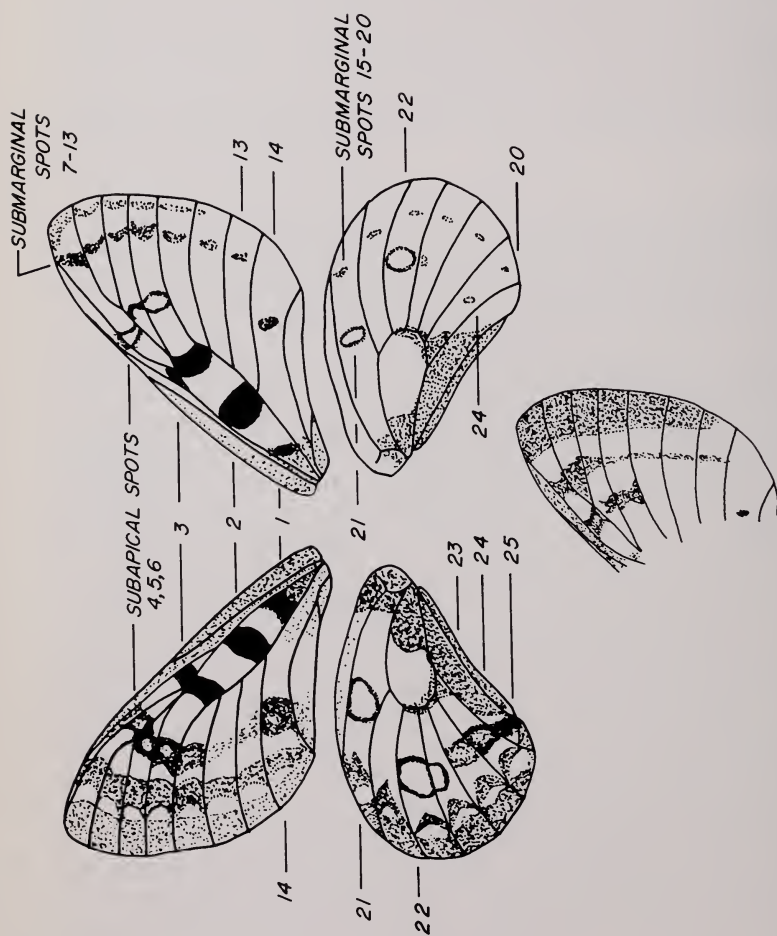


Fig. 1.—Maculation and spot designation in *Parnassius phoebus*, Male, top right; female, top left of *smintheus* group. Male FW of *behrri* group, bottom.

acter in *Parnassius* was recognized by Müller, 1954. Table I indicates group assignments for the non-arctic taxa listed above. Those which I consider as valid subspecies, as subsequently discussed, appear to the left with their synonyms offset to the right.

TABLE I

*Parnassius phoebus* groups

<i>smintheus</i> group	<i>behrii</i> group
<i>smintheus</i>	<i>behrii</i>
<i>nanus</i>	<i>sternitzkyi</i>
<i>xanthus</i>	<i>olympianus</i>
<i>magnus</i>	<i>guppyi</i>
<i>sayii</i>	<i>pseudorotgeri</i>
<i>hermodur</i>	
<i>hollandi</i>	
<i>dakotaensis</i>	
<i>rotgeri</i>	
<i>rubina</i>	
<i>montanulus</i>	
<i>maximus</i>	

The *smintheus* group:

This group is recognized, as shown in Figure 1, by the reduced unscaled areas from the apex of the FW in the males and along the margin. The aspect is one of marginal chevrons or white spots interspersed with a dark (unscaled) band followed basad by a white band and a dark spot row (spots 7 - 13) which may be obsolete in some examples. Discussion proceeds according to geography from the Great Basin eastward and northward rather than in the chronological order indicated in Table I.

Wyatt's primary basis for describing *rubina*, 1961, was its geographic isolation from other races. He also cited *hollandi* from Utah as an isolated race. Careful examination of specimens produces no significant differences between the two subspecies. I can detect only two very slight differences. The FW black spot in cell Cu<sub>1</sub>, spot 14 (see Figure 1 for nomenclature) is slightly smaller and rounder in *hollandi* and the bottom of spot 3 extends distally slightly along the vein in *rubina*, while ending abruptly in *hollandi*. The remaining maculation: spot size, borders, red versus black spots, etc., exhibits the normal range of



variability associated with *phoebus*. I would find it very difficult to separate a specimen of *rubina* from a series of *hollandi* and vice versa without looking at locality labels.

Wyatt's descriptions for both *rubina* and *guppyi* (discussed subsequently) do not satisfy the criteria specified by the I.C.Z.N., as he does not clearly distinguish how his proposed taxa differ from other recognized subspecies. In his description of *rubina*, he briefly mentioned *hollandi* and then stated the physical characters of the two type specimens of *rubina*. No discussion of variation was presented.

Albeit that they are geographically separated by some distance, in facies *hollandi* and *rubina* appear to be the same insect. At best, *hollandi* can be considered only a weak subspecies closely allied to *sayii*. The variation observed in both *hollandi* and *rubina*, including spot 3, is well within the normal range for *sayii*. Although there is geographic isolation from the main populations of *sayii*, since there are no clear phenotypic differences, I am assigning both taxa to *sayii*.

The subspecies of *phoebus* associated with the central Rocky Mountains is *sayii*. Brown, 1975, gives a detailed discussion of the type locality of this subspecies with designation of a neotype to replace the lost type. He also cites the error made by Bryk and Eisner, 1935, in assigning the type locality to the Judith Mountains in Montana. The neotype female is from Elbert Co., Colorado, which is close to the "Pike's Peak" locality cited by Edwards for the original type. The range of *sayii* is from NE Nevada, central and NE Utah, central Colorado (Pike's Peak region) into central and NE Wyoming, thence into the Black Hills of South Dakota. There appears to be no reason for retaining *dakotaensis* as a separate subspecies. The maculation exhibited fits well within the normal range for low-altitude *sayii*. The type series for *dakotaensis* contained specimens from the vicinity of Deadwood, Lawrence Co., South Dakota, undesig-nated locality specimens from Wyoming, and specimens from the Big Horn and Teton Mountains in Wyoming. As discussed later, material from the two latter localities should be referred to *montanulus*.

It seems quite evident that *hermodur* is simply the altitudinal form, more pronounced in the females, of *sayii*. There has been quite a bit of confusion in the past as to what exactly is phenotypic *hermodur*. Elrod, 1906 (p. 14-15, figs. 13-14), figured low-altitude *sayii* as *hermodur* and also reversed the sexes. Howe, 1975, has figured two specimens, neither of which is *hermodur*.

The female shown in plate 67, fig. 10 from Mt. Evans, Clear Creek Co., Colorado appears to be low-altitude *sayii* or a poor illustration. The male shown in plate 68, fig. 7 from Telluride, San Miguel Co., Colorado is *pseudorotgeri*, a member of the *behrii* group. The elevation cited, 8000' (2438 m.) is much too low for *hermodur*. The insect is correctly figured in Brown et al., 1957 (p. 234). What Holland, 1898, illustrated as *hermodur* (pl. 39, fig. 6) is closer to high-altitude *montanulus*.

The *hermodur* form appears in most high-altitude populations of North American *phoebus*. Southeastern Wyoming provides an excellent opportunity to observe *sayii* from the prairie association high plains through a continuous gradation into the mountains above treeline where *hermodur* flies. Throughout the Rocky Mountains, low-elevation *phoebus* tend to be much larger and more brightly marked than specimens taken at high elevations. With increasing altitude, the females become smaller and darker, with the ground color of the wings tending toward charcoal gray. On the other hand, the males become smaller and more lightly marked. This change in color and maculation is easily observed in the continuous cline from the Laramie Plains (ca. 7000', 2134 m.) through the Transition Zone foothills (ca. 8000-9000', 2438-2743 m.) and into timberline habitats on Snowy Range Pass (10,800', 3292 m.) in the Snowy Range Mountains, Albany Co., Wyoming. In this region, there is a continuous band of *Sedum lanceolatum* Torrey, the hostplant, and there are no barriers that produce isolated colonies. Specimens can be collected nearly everywhere along Hwy. 130 from east of Centennial westward to the summit. Thus *hermodur* is sunk as the altitudinal form of *sayii*. The reason for the dark color in the females relates to development at reduced temperature (high altitudes) results in the production of more melanin and hence darker tones. This phenomenon is sometimes called thermal adaptation.

In the north-central to northwestern Rocky Mountains, the picture becomes somewhat more confused. The Red Desert in Wyoming presents a natural zoogeographic barrier of approximately 100 miles (150 km.) between the northern foothills of the Sierra Madre Range (an extension of the Colorado Western Slope) and the southern boundary of the Wind River Range (the northern continuation of the Rocky Mountains). In Utah, *sayii* is found from the SE to NW portion of the state as shown in Figure 2. It occurs in the Wasatch and Uinta Ranges which

border Wyoming on the south and west of the Red Desert region.

*Parnassius phoebus* again appears in numbers in Lincoln Co., Wyoming in the Salt River Range and in the Snake Range in Teton Co., thence into Idaho and Montana. In southern Lincoln Co., a wide variety of forms is taken, indicative of a clinal situation or tension zone. To the north, especially in Park Co., (the Beartooth Plateau) a distinct phenotype emerges. The males are larger than high-altitude *sayii* (although occurring at comparable altitudes) and the females are more brightly marked. There is a distinct basal cream coloring in the wings of the females, but the outer half of the wings is almost transparent (unscaled) charcoal gray. There is a submarginal FW cream colored spot row as in form *hermodur*. The two red HW spots (21-22) tend to be pupiled with white. The males appear less inclined toward FW red spotting. As with *sayii*, one observes a gradual change in facies from the arctic-alpine region inhabitants to those found in the deep canyons at lower elevations.

The population from the two summits of Beartooth Pass on the Beartooth Plateau (Park Co., Wyo. - Carbon Co., Mont.) and extending NE to Red Lodge, Montana shows considerable variability and comprises specimens resembling the holotypes and paratypes of both *montanulus* and *maximus*. About 5 airline miles separate the summit area from the lowest elevation where *phoebus* is found. Elsewhere in Montana, similar specimens can be collected, including the Glacier National Park region. I can see no basis for retaining both names and therefore sink *maximus* as a synonym of *montanulus* which carries publication priority.

We now come to the taxon *smintheus* Doubleday (not W. H. Edwards, see Brown, 1975). Doubleday's material came from Laggan (Lake Louise) and the Banff area in Alberta. From the same general area, Neumoegen described *nanus* (near "Ft. Calgary" and Spence's Bridge, British Columbia). The former locality is Calgary, Alberta, while the latter is in British Columbia. I suspect that the Calgary specimens were actually collected in the mountains to the west of the settlement, that is the east slope of the Canadian Rockies. Many old records cite the nearest settlement rather than the actual collection locality. Neumoegen's description (1890) is somewhat confusing. It could apply equally well to the high-alpine *sayii* from Colorado. Specimens from the upper reaches of Whitehorn Mtn. near Banff fit Neumoegen's description reasonably accurately. Thus *nanus* appears to be an altitudinal form of *smintheus* in the same manner as *hermodur* is to *sayii*.



Transition Zone *smintheus* resembles *sayii* from the same zone, but there is considerably more red marking in the females. Spots 4 - 6 are generally markedly red as are spots 24 - 25. Spots 21 - 22 are very large and boldly red with 22 extending well into cell  $M_3$ . Both may be white pupiled. Spots 24 and 25 are large and 23 is frequently present. The females are the most boldly marked of the non-arctic *phoebus*.

Specimens of *phoebus* from central and eastern Washington, eastern Oregon, and Idaho exhibit a cline between *smintheus* and *montanulus*. Two names have been applied to Idaho material. In 1918, Ehrmann described *xanthus* from Moron [sic], Moscow, Latah Co., Idaho (Avinoff in Holland, 1927). Without any reference to Ehrmann's action, Bryk and Eisner described *idahoensis* from Wallace, Shoshone Co., Idaho in 1931. The type series included specimens from "Pine Creek", Idaho (probably Pine Ck. Pass, Bonneville Co.), and Mt. Spokane, Spokane Co., Washington. Wallace and Mt. Spokane are close to Moscow. In 1964, dos Passos placed *idahoensis* as a junior synonym of *xanthus*. Specimens from Yakima Co., Washington are very close to *smintheus* although a bit lighter colored and less heavily maculated. Some males, however, exhibit the transparent wing borders associated with the *behrii* group. Yakima Co. appears to represent a tension zone between the *behrii* complex and the *smintheus* complex. Material from Idaho is quite variable. Some specimens blend into *montanulus*, while others are quite close to *smintheus*, especially in the northern portion of the state where the intrusion of spot 22 into cell  $M_3$  is observed in the females. As would be expected in a clinal situation, there is considerable variation within colonies and throughout the range of *phoebus* from central Idaho into Oregon and Washington. I do not feel that material from this region merits nomenclatural recognition. Based upon the illustrations which appear in the original description of *idahoensis* and the localities from which both *xanthus* and *idahoensis* were described, I am sinking both taxa as synonyms of *smintheus*, although it should be understood that the two names apply to a very variable cline. Ehrmann described *xanthus* from a single pair, and the type series of *idahoensis* contained 17 specimens. Specimens from Cassia Co., Idaho on the Utah border are referable to *sayii*.

Wright, 1905 (pl. 2, fig. 13, b) described *magnus* from two specimens taken by an unknown collector at Enderby, British Columbia, ca. 1880. His description applies better to *montanulus* than to the type specimens illustrated. Cited are the large size

and the more defined markings in both sexes. The type pair which he illustrated fits perfectly into my series of *smintheus* taken south of Banff, Alberta along the Kananaskis Highway. Specimens from Lac La Hache and Pavilion Mtn., near Jesmond, British Columbia are similar. Thus *magnus* appears to be simply the Canadian Rocky Mountain western slope form of *smintheus* parallel to the eastern slope-western slope relationship of *sayii* in Colorado. Recall that *nanus* was described from specimens taken on both slopes. For these reasons, I am sinking *magnus* as a synonym of *smintheus*.

It appears that much of the confusion concerning the true identity of *smintheus* was generated by W. H. Edwards when he applied the name to all red-spotted *phoebus* from North America. This has resulted in the redescription of the insect under other names.

In the Rocky Mountains, *sayii* and *smintheus* respectively, represent the southern and northern phenotypes of the *smintheus* group. The name *montanulus* has been retained to describe the fairly uniform specimens which occur in northern Wyoming and Montana. One could, however, justify retaining only the taxa *sayii* and *smintheus*, with the remainder of the Rocky Mountain population designated as a cline.

The *behrii* group:

This group is characterized by the diaphanous margins of the FW in the males. From the apex to vein  $Cu_1$  and sometimes to  $Cu_2$ , the margins are virtually unscaled, which gives them a charcoal gray aspect. Unscaled margins are characteristic of the females of both *phoebus* groups. The subspecies *behrii* is rapidly separated from all other U.S. subspecies of *phoebus* by its characteristic yellow-orange rather than red spots. It inhabits the Sierra Nevada of California and detailed discussion of this butterfly appears in Brown, 1975.

In 1936 [1936c in Lit. Cited], McDunnough recognized that the red-spotted northern California *phoebus* was not *smintheus* and he named it *sternitzkyi*. He cited two major characters which separated the new taxon from other *phoebus*. The first is the chalky white ground color, which is apparent in older specimens, but less apparent in freshly caught material. The chalky white color appears in worn specimens from high altitudes in the *smintheus* group. The other character was cited as "the broad unicolorous dark (unscaled) marginal band on the forewings extending down to vein  $Cu_1$  and containing none of the

whitish triangular marks along the outer margin found to a greater or less extent in both the other races [*magnus* and *sayii*]."

In my opinion, *olympianus* and *guppyi* are synonyms. Wyatt's description of *guppyi* refers to its larger size, stronger maculation and the more prominent spot in cell Cu<sub>2</sub> (spot 14) of the FW (1969). In comparing topotypical specimens of both taxa, I can find no significant size difference and the other characters are quite variable. The variation is no more extreme, however, than one would find in a somewhat geographically restricted subspecies such as *behrii*.

Burdick, 1941, in his description of *olympianus* compared the new taxon with *behrii* rather than *sternitzkyi*, to which it is both geographically and phenotypically more closely related. The two subspecies are quite closely related, but there are some minor characters in which they consistently differ. These are ground color and degree of maculation, especially in the females where *olympianus* is the more darkly marked. It may be that *olympianus* represents the altitudinal form of *sternitzkyi* in the same manner as the relationship between *sayii* and *hermodur*. This cannot be proved at the present time, as *sternitzkyi* is known only from northern California and southern Oregon, and *olympianus* from northwestern Washington and Vancouver Island.

The Burdick collection is at the University of Colorado Museum in Boulder. I examined the spread (10 pairs) and papered paratypes in the collection. Three of the spread males exhibited quite strongly the FW marginal white chevrons or marks associated with the *smintheus* complex. This maculation also occurs in some imagines of *behrii*.

Material from the San Juan Mountains in southern Colorado and the southern end of the Sangre de Cristo Mountains in northern New Mexico also belongs to the *behrii* group, as the males very strongly exhibit the diaphanous margins of the FW. Chermock proposed the name *pseudorotgeri*, based no doubt upon the insect's small size and superficial resemblance to *rotgeri*, but he did not publish the name. Eisner used the name, credited to Chermock, in a 1964 paper, and then published the taxon with a description of the butterfly under his own name in 1966 [1966a].

The two taxa, *rotgeri* and *pseudorotgeri* should be clearly distinguished. The former was described by Bang-Haas from Mt. Evans, Clear Creek Co., Colorado in 1938 and was a re-description of *hermodur*. Bang-Haas based his action upon Bryk's description of *hermodur* in Das Tierreich which led him

to believe that the Mt. Evans material was significantly different from *hermodur*. Unfortunately Bryk's concept of *hermodur* was incorrect. The type specimens illustrated by Bang-Haas (pl. 1, figs. 6, 9) are clearly high-altitude *sayii* and *rotgeri* falls as a junior synonym of *hermodur*, which is the altitudinal form of *sayii*.

*P. ph. pseudorotgeri* clearly belongs to the *behrii* group. Eisner apparently was unable to recognize the diagnostic differences between it and *rotgeri*, for in his 1966 paper he noted that *pseudorotgeri* matched very closely his [Eisner's] paratypes of *rotgeri* and suggested that Bang-Haas may have had incorrect locality data. Despite Eisner's sixty-seven descriptors that he has used to separate *Parnassius* forms, he missed, as did Bryk, the one feature that separates the members of the two *phoebus* groups in North America, namely the margins of the FW in the males. Table II presents sufficient information to separate *pseudorotgeri* from high-altitude *sayii*. It is a small insect and the males are clearly of the *behrii* form. The females exhibit broad diaphanous wing borders both FW and HW, but the basal and discal areas are white scaled. They do not have the dusky appearance of form *hermodur*. The tension zone between *sayii* and *pseudorotgeri* extends from Trinchera Peak in the Spanish Peaks of Las Animas Co., Colorado through the Wet Mountains in Huerfano Co., into Alamosa and Conejos Cos., Old Baldy Mtn., Costilla Co., and westward into Mineral (Treasure Mtn.), San Juan and San Miguel Cos., as shown in Figure 2. High-altitude specimens from the tension zone may look like either *rotgeri* or *pseudorotgeri*. The females can usually be separated into one or the other; the males look basically like *pseudorotgeri*, but the white maculation appears in the FW diaphanous margin. Low altitude specimens from the tension zone tend toward more typical *sayii*.

In New Mexico, *pseudorotgeri* occurs in isolated pockets in the high mountains of the northern part of the state. One specimen in the University of Colorado collection exhibits the yellow spots (both upper- and undersides) associated with *behrii*. It was taken along with normal red-spotted specimens on Chama Peak, 11,500-11,900' (3502-3627 m.), Rio Arriba Co., New Mexico by L. E. Chadwick on August 11, 1935. This specimen, in other respects, looks like *pseudorotgeri*. It has the wide diaphanous FW margins and the relatively light maculation characteristic of male *pseudorotgeri*; *behrii* is a much more heavily marked subspecies. Occasional red-spotted specimens occur in



*behrii*, although yellow is the normal color.

Of the arctic races, *alaskaensis* and *golovinus* belong to the *behrii* group; *apricatus* appears to belong to this group based upon a rather poor photocopy of the plate accompanying the original description. Specimens or photographs of *elias* males were not available for examination; *yukonensis* belongs to the *smintheus* group.

In several areas, interaction between the two groups occurs, or has occurred in the past. Strong interaction is observed in the southern Colorado tension zone between *sayii* and *pseudorotgeri*. Specimens from Yakima Co., Washington generally represent the *smintheus* group, but occasional specimens exhibit the *behrii* group FW margins, indicative probably of interactions with *olympianus* to the west, while some specimens of *olympianus* show the white chevrons typical of *smintheus*. About ten percent of nearly 100 specimens examined from the Minam area in Wallowa Co., Oregon showed the *behrii* FW border.

A most unusual record is the collection of three *phoebus* by the late A. H. Moeck near Victoria, Tamaulipas, Mexico. Through the courtesy of Dr. Allen M. Young of the Milwaukee Museum, where the Moeck collection is housed, I was able to examine a pair of these specimens. They represent the *smintheus* group and are closest to low-altitude *sayii*. Except for the spots (4, 6, 21, 22) which were orange on the specimen studied, the male was quite similar to typical *sayii*. The same spots on the female were red and the submarginal spot row (spots 15-20) was formed of very distinct chevrons, much more distinct than in any other female *phoebus* examined. Otherwise, the specimen appeared as typical *sayii*. The pair was collected at 1500' (457 m.) on 3 July, 1952. No more specific locality data were given than cited above. After examining the specimens, I have no reason to question the validity of this record. These specimens may represent a describable subspecies, but to do so based upon two specimens would be foolish.

## BIOLOGY

The life history of several of the *phoebus* subspecies, *sayii* in particular, is well known. David Brucc and W. H. Edwards collaborated in the collection of ova and the rearing of *sayii* at Hall Valley, Park Co., Colorado. The ova are broadcast by the

females as they flutter close to the ground. The newly hatched larvae are thus forced to seek out the foodplant. Throughout its range, *phoebus* is associated with *Sedum*, primarily *lanceolatum* Torrey. Tietz, 1972 listed a variety of hostplants, including *S. debile* S. Wats., *S. obtusatum* Gray, and *S. wrightii* A. Gray. His records for *Carex*, *Gayophytum* and *Phlox* should be considered doubtful. *Saxifraga* has also been cited as a foodplant. In Wyoming, *S. lanceolatum* seems universally to be the larval hostplant. In southern Colorado, *pseudorotgeri* uses *S. rhodanthum* A. Gray and *S. integrifolium* Hook. (B. Rotger in litt.).

The larvae feed until late summer, in some areas, hibernate over the winter, and complete the life cycle the following summer. On Vancouver Island, the larvae emerge during the winter and apparently remain dormant until spring (R. Guppy in litt.). It has not yet been determined if the life cycle there is completed in one or two years. The mature larvae are velvety black with conspicuous yellow spots. The smooth brownish pupae are formed in the debris on the ground and are covered by loosely woven cocoons. Typically the pupal stage lasts from 2 to 3 weeks.

Detailed descriptions of the immature stages are to be found in W. H. Edwards, Butterflies of North America, 3rd Series, 1897; J. A. Comstock, Bull. S. Cal. Acad. Sci. 25:62, 1926; 29: 135-136, 1930.

## SUMMARY

Several factors have become apparent during the course of this study which have contributed to the taxonomic problems surrounding *P. phoebus* in North America. Many of the taxa have been erected by European workers who have studied isolated specimens in museum collections. In addition, it is quite evident that they had no appreciation of North American geography and topography. In many cases, only a very limited number of specimens was examined. With as highly variable a species as *phoebus*, this practice can lead to misconceptions. Examination of many original descriptions has indicated that the authors were totally unfamiliar with prior publications in the field. In several instances, taxonomic findings were based upon interpretations of other workers without checking source material. This has resulted in the establishment of unnecessary taxa and the redescription of subspecies.

The source specimens used by several European authors were primarily purchased from dealers. In many cases, locality data was sketchy or incorrect. Museum specimens tend to fade which leads to erroneous concepts concerning facies. Anyone studying *Parnassius* should have long series of fresh specimens before him before making taxonomic pronouncements. He should also be aware of geography and existing literature; three factors it seems that our European colleagues have neglected.

In the present paper, an attempt has been made to arrange the taxa according to consistent characters as noted in the text and delineated in Table II. This may not be the optimum arrangement, but it presents a rational approach to resolving the long-standing confusion concerning *phoebus*. Based upon the analysis cited in this paper, a checklist is given below in which the major synonymies are listed. As previously noted, additional synonymies are shown in dos Passos, 1964.

*PARNASSIUS phoebus* Fabricius

*apricatus* Stichel, 1906 \*

*golovinus* Holland, 1930 \*

*elias* Bryk, 1934

*alaskaensis* Eisner, 1957 \*

*yukonensis* Eisner, 1969 \*\*

*smintheus* Doubleday, 1847

*nanus* Neumoegen, 1890

*magnus* Wright, 1905

*xanthus* Ehrmann, 1918

*idahoensis* Bryk and Eisner, 1931

*montanulus* Bryk and Eisner, 1935

*maximus* Bryk and Eisner, 1937

*sayii* Edwards, 1863

*hermodur* H. Edwards, 1881 Altitudinal form

*hollandi* Bryk and Eisner, 1935

*dakotaensis* Bryk and Eisner, 1935

*rotgeri* Bang-Haas, 1938

*rubina* Wyatt, 1961

*behrii* Edwards, 1870

*sternitzkyi* McDunnough, 1936

*olympianus* Burdick, 1941

*guppyi* Wyatt, 1969

*pseudorotgeri* Eisner, 1966

\* arctic race, *behrii* group

\*\* arctic race, *smintheus* group

TABLE II  
Spot Characteristics in *Parnassius phoebus*

[These are *average* characters over a series; extreme individuals occur in any series.]

Subspecies	Spot 1	Spots 4 - 6	Spots 7 - 13	Spot 14	Spots 15 - 20
<i>sayii</i>	m variable, weakly present in LA, usually absent HA f present	distinct na	distinct ex 13 na	faint-to-absent usually black	faint & freq absent ex LA na
<i>montanulus</i>	m variable, weakly present HA, LA f well-developed	faint ex LA na	faint na	absent ex LA often red-ctr	absent na
<i>smithaeus</i>	m usually absent f less opaque than <i>montanulus</i>	usually sm 4, 6 prominent & red-ctr	faint na	absent lg usually red-ctr	absent na
<i>behrii</i>	m absent f absent	variable, sometimes, orange-ctr dark smear, sometimes lg with orange centers	present na	absent distinct & black	present, 15, 16 freq missing na
<i>sternitzkyi</i>	m absent f faint when present	lg, red-ctr lg, red-ctr	present na	small lg, usually black	variable na
<i>olympianus</i>	m absent f present	small lg red-ctr	present na	absent lg, red-ctr	variable na
<i>pseudorotgeri</i>	m absent f faint	faint, 6 may be red-ctr present, freq red-ctr	present 11, 12 absent na	small-to-absent black	variable, faint na

Abbreviations used: ctr = center/centered; esp = especially; ex = except/excepting; freq = frequently; HA = high altitude; LA = low altitude; lg = large; na = not applicable as a distinguishing character; sm = small.



TABLE II (Continued)

Subspecies	Spots 21, 22	Spot 23	Spot 24	Spot 25
<i>sayii</i>	m small ex LA f freq white-pupiled, but not extending into cell M <sub>3</sub> ex LA	absent very sm or absent	very faint if present sm, some red in LA	absent sm to indistinct
<i>montanulus</i>	m prominent f freq white-pupiled & extending into cell M <sub>3</sub>	absent faint-to- absent	absent, present LA, black sm, often red-ctr	absent sm, usually black
<i>smintheus</i>	m sm & often white-pupiled f lg, freq white- pupiled & extends deeply into cell M <sub>3</sub>	absent usually present	absent lg & red-ctr	absent distinct & freq red-ctr
<i>behrii</i>	m sm, orange-ctr f sm, orange-ctr	absent absent	absent sm, black	absent sm, black
<i>sternitzkyi</i>	m lg, often white-pupiled f lg, extends into cell M <sub>3</sub>	absent small	small red-ctr	variable red-ctr
<i>olympianus</i>	m sm, often white-pupiled f lg, freq white- pupiled, extends into cell M <sub>3</sub>	absent indistinct	absent red-ctr	absent red-ctr
<i>pseudorotgeri</i>	m sm, esp 21 f medium, often white-pupiled	absent absent	absent sm, black	absent sm, black

In the females of the high-altitude specimens of the *smintheus* group, *smintheus* is the lightest colored and *sayii* is the darkest.

Figure 2 shows the distribution of *P. phoebus* in the region treated by this paper. To conserve space, individual locality records are not cited. Many hundreds of specimens were examined during the course of this study. Records by province, state and county are: *smintheus*: **BRITISH COLUMBIA**: southern portion; **ALBERTA**: southern portion in and along Rocky Mountains. *montanulus*: **ALBERTA**: Waterton Park; **IDAHO**: Bonneville, Fremont, Teton; **MONTANA**: Beaverhead, Carbon, Cascade, Chouteau, Fergus, Flathead, Gallatin, Glacier, Granite, Jefferson, Judith Basin, Lake, Lewis and Clark, Lincoln, Madison, Meagher, Mineral, Missoula, Park, Powell, Ravalli, Sanders, Sweet Grass; **WYOMING**: Big Horn, Fremont, Johnson, Lincoln, Park, Sheridan, Sublette, Teton, Washakie, Yellowstone N. P.; *sayii*: **COLORADO**: Boulder, Chaffee, Clear Creek, Custer, Delta, Dolores, Douglas, Eagle, Elbert, El Paso, Fremont, Garfield, Gilpin, Grand, Gunnison, Jackson, Jefferson, Lake, Larimer, Mesa, Moffat, Montrose, Ouray, Park, Pitkin, Pueblo, Routt, Saguache, Summit, Teller; **NEBRASKA**: Sioux; **NEVADA**: Elko; **SOUTH DAKOTA**: Lawrence, Pennington; **UTAH**: Cache, Davis, Duchesne, Emery, Grand, Rich, Salt Lake, San Juan, Summit, Tooele, Uintah, Utah, Wasatch, Weber; **WYOMING**: Albany, Carbon, Converse, Crook, Sweetwater, Weston. *behrii*: **CALIFORNIA**: Alpine, Amador, Calaveras, El Dorado, Fresno, Madera, Mariposa, Mono, Nevada, Placer, Plumas, Sierra, Tulare, Tuolumne. *sternitzkyi*: **CALIFORNIA**: Shasta, Siskiyou, Trinity; **OREGON**: Jackson, Josephine. *olympianus* **BRITISH COLUMBIA**: Vancouver Island; **WASHINGTON**: Clallam, Okanogan. *pseudorotgeri*: **COLORADO**: Archuleta, Hinsdale, La Plata, Rio Grande, San Miguel; **NEW MEXICO**: Mora, Rio Arriba, Santa Fe, Taos. *sayii* — *pseudorotgeri* intergrades: **COLORADO**: Alamosa, Conejos, Costilla, Huerfano, Las Animas, Mineral, San Juan. *montanulus* - *smintheus* "*xanthus*" intergrades: **IDAHO**: Ada, Adams, Blaine, Boise, Clearwater, Custer, Latah, Lemhi, Shoshone; **OREGON**: Baker, Grant, Morrow, Umatilla, Union, Wallowa; **WASHINGTON**: Asotin, Chelan, Garfield, Klickitat, Okanogan, Pend Oreille, Pierce, Skagit, Spokane, Whatcom, Yakima.

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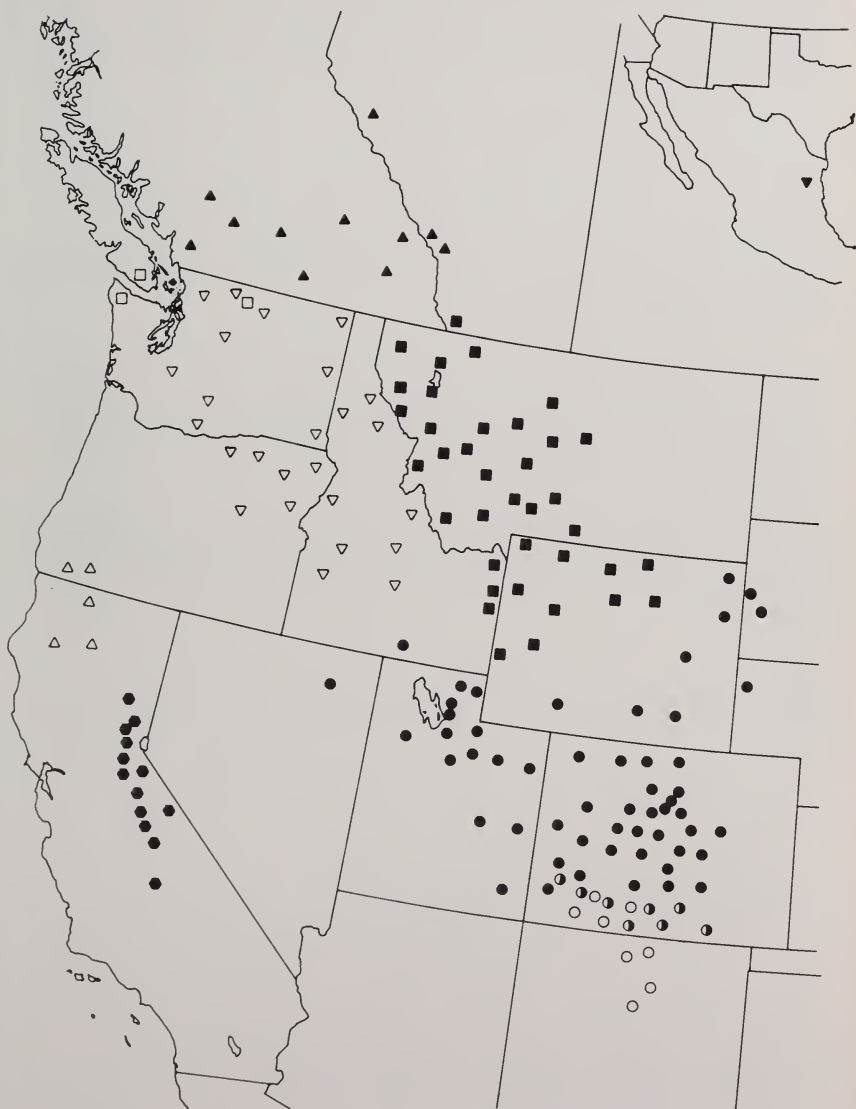


Fig. 2.—Distribution by county of non-arctic *P. phoebus* in North America. Solid triangles = *smintheus*; open triangles = *sternitzkyi*; inverted solid triangle = Mexican race; inverted open triangles = clinal forms; hexagons = *behrii*; solid circles = *sayii*; open circles = *pseudorotgeri*; half-open circles = *sayii* - *pseudorotgeri* cline; solid squares = *montanus*; open squares = *olympianus*.

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Also acknowledged is the work of the Shepards which appeared in Howe, 1975. This author was rather critical of their discussion (Ferris, 1976). In retrospect, the Shepards made a step in the right direction regarding *phoebus* but could have carried the study further.

It is frequently difficult to track down original descriptions and figures of type or typical specimens. Table III (below) indicates where this information can be found for the taxa treated in this paper.

TABLE III

Source Materials in which Illustrations of the Non-arctic North American *Parnassius phoebus* Type Specimens are to be Found

(See citations in Literature Cited section)

*behrii*: Neotype, Brown, 1975, fig. 3, p. 10.

*dakotaensis*: Eisner, 1966b, figs. 4, 5, pl. 22.

*guppyi*: Wyatt, 1969, figs. 1-4, pl. 15.

*hollandi*: Paratypes, Eisner, 1955a, figs. 1-4, pl. 23.

*hermodur*: Not figured by Edwards; figured by Skinner, 1916, pl. XII, fig. 8, female type no. 2791 in the Edwards Collection of the American Museum of Natural History, New York.

*idahoensis*: Bryk and Eisner, 1931, figs. 4, 5, p. 5.

*magnus*: Wright, 1905, figs. 13, 13b, pl. 2.

*maximus*: Eisner, 1957, figs. 1, 2, pl. 4.

*montanulus*: Eisner, 1957, figs. 5, 6, pl. 4. Typical specimens in Eisner, 1964, figs. 1, 2, pl. 2.

*nanus*: Not figured by Neumoegen; figured by Skinner, 1916, pl. XII, figs. 4-6.

- olympianus*: Burdick, 1941, p. 118. Typical specimens in Eisner, 1964, figs. 3, 4, pl. 2.
- pseudorotgeri*: Not figured by Eisner. A typical male is figured incorrectly as *hermodur* by Howe, 1975, fig. 7, pl. 68.
- rotgeri*: Bang-Haas, 1938, figs. 6, 9, pl. 1.
- rubina*: Wyatt, 1961, figs. 1, 2, pl. 11.
- sayii*: Neotype, Brown, 1975, fig. 2, p. 7.
- smintheus*: Doubleday, 1847, fig. 4, pl. 4.
- sternitzkyi*: McDunnough 1936c, p. 273.
- xanthus*: Not figured by Ehrmann; figured by Howe, 1975, figs. 13, 14, pl. 69, Wallace, Shoshone Co., Idaho specimens (close to *smintheus*).

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*Note:* Lee D. Miller of the Allyn Museum of Entomology has pointed out that the noted collection locality for Moeck's *phoebus* is thorn desert. Most probably the specimens were taken in the high mountains southwest of Victoria (Sierra Madre Orientale).

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## CHROMOSOME NUMBERS IN TWO SPECIES OF *ERGOLIS* (LEPIDOPTERA: NYMPHALIDAE)

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### ABSTRACT

Chromosome number of two species of *Ergolis* viz., *E. ariadne* and *E. merione* belonging to the family Nymphalidae is reported, the former for the first time. The role of Robertsonian changes as means of speciation in the genus *Ergolis* is examined.

THE COSMOPOLITAN GENUS *ERGOLIS* has two representative species in India, viz., *E. ariadne* (Johanssen) and *E. merione* (Cramer) which are distributed all over the country except in arid north and northwest regions (Wynter-Blyth 1957). Although the chromosomes of a number of nymphalid butterflies were hitherto reported, the chromosome number was reported for only two species of *Ergolis* i.e. *E. pagenstechier* by Lesse (1968) and *E. merione* by Rishi (1973, 1975). The present communication reports the chromosome number of the two Indian species, of which, one is worked out for the first time.

The butterflies were collected from the fields around Postgraduate Centre, Guntur, South India. Testes were vivisected from adults immediately after collection and squashed in 2% acetic orcein without prefixation. Both metaphase I and metaphase II stages, and in one species spermatogonial mitotic metaphases were studied. Photographs were taken and camera lucida figures were drawn using a x 100 oil immersion lens.

Metaphase I stages of *E. ariadne* (Fig. 1) whose chromosome number is worked out for the first time, clearly show 31 bivalents. All the bivalents, with an exception of one, are almost of the same size with terminally associated homologues. Terminalisation is complete in all the bivalents by the time the cell enters metaphase I.

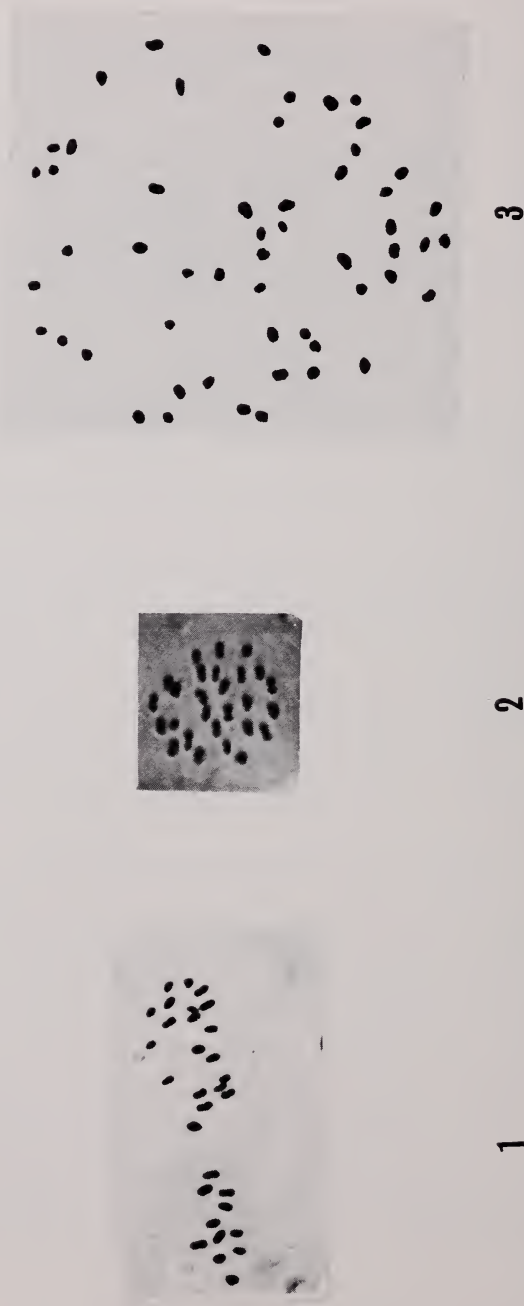


Fig. 1.—Metaphase I stage of *E. ariadne*.  
Fig. 2.—Metaphase I stage of *E. merione*.  
Fig. 3.—Mitotic metaphase of *E. merione*.



Metaphase I stages of *E. merione* (Fig. 2) show clearly 27 bivalents with very little size variation. All the bivalents are dumb-bell shaped with fully terminalised chiasma. Mitotic metaphases (Fig. 3) show 54 dot-like, almost isodiametric bodies which again confirm the haploid number as 27.

The haploid chromosome number of *E. ariadne* is the same as the modal number of the order Lepidoptera and also of the family Nymphalidae.

Our observation of 27 haploid chromosomes in *E. merione*, based on studies of both mitotic and meiotic metaphases is at variance with the report of Rishi (op. cit) who claimed to have observed 26 bivalents at metaphase I and 52 elements in spermatogonial metaphase of testes of larvae collected at Chandigarh and Kalka (N. India). The difference in the chromosome number in specimens collected from different regions, if it is well established, indicates the divergence of the species into distinct geographical populations as a first step in speciation.

The remarkable difference in chromosome numbers of the closely related Indian species is well reflected in the readily distinguishable morphological characters. In *E. ariadne*, the forewing is deeply concave between veins 3 and 5, black lines on the dorsal surface of forewing occur singly and the discal line is single in contrast to the much rounded termen, black lines on the dorsal surface of forewing being highly wavy and occurring in twos and discal line being double in *E. merione*. (Wynter-Blyth op. cit).

The divergence in the chromosome number of the three species of *Ergolis* whose chromosome number is now known i.e. *E. pagenstecher* ( $n=36$ ), *E. ariadne* ( $n=31$ ) and *E. merione* ( $n=27$ ) points out that fusion as well as fragmentation seem to have occurred in this genus. That such Robertsonian phenomena, whose occurrence is rendered easier by the diffuse kinetochore in the Lepidoptera, are at play, leading to the establishment of distinct geographical races, subspecies and species, is now widely recognised. (Suomalainen 1965, Bauer 1967).

#### ACKNOWLEDGEMENTS

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NOTES ON THE BIOLOGY OF  
*LAMPROPTERA CURIUS WALKERI* MOORE  
(LEPIDOPTERA; PAPILIONIDAE)

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Department of Entomology  
(British Museum [Natural History])

DR. AND MRS. J. CAREY-HUGHES VISITED the Department of Entomology of the Natural History Museum in December 1967 and asked if there were any butterflies in Hong Kong whose life-histories needed investigation. It was suggested that they might try and rear *Lamproptera curius walkeri* Moore as there seemed to be some points which needed clarification concerning its early stages and the relationship of the genus *Lamproptera* (Tribe *Leptocircini*) with the remaining *Papilionidae* (see Munroe, 1961:7 and Munroe & Ehrlich, 1960:173).

On their return to Hong Kong, they succeeded in breeding this interesting butterfly from the egg and sent the following notes which they have been kind enough to allow me to submit for publication.

Though Mell (1938:340-1, pl. 7, figs 9, 9a, 18) described and figured the immature and mature larva and pupa in colour of this subspecies, from China, unfortunately the figures do not show much detail and it is hoped that these notes and the reproductions of the excellent colour photographs made by Dr. Carey-Hughes, together with Mell's detailed descriptions will be of interest to those concerned with biology and the higher classification of the *Papilionidae*.

Dr. Carey-Hughes wrote on 18th November 1968 as follows:

"There are probably five broods per year in Hong Kong and we believe the insect to be locally not uncommon where its food plant *Illigera platyandra* Dunn family *Hernandiaceae*, occurs. (Mell gives *Illigera rhodantha* Hance as a food-plant.) This is a climbing shrub with composite leaves of three leaflets. The eggs are laid on both surfaces of the leaves. The osmaterium (of the larva), in the early stages at least, is translucent. The larvae pupate on the side of the leaf away from the light and while

under natural conditions this is usually the underside, in our breeding conditions many pupated on the upperside of the leaf too. The flight of the insect is *not* like a dragonfly which is darting, but more sedate and the wing beats are not so rapid.

Our breeding notes for May follow:

- 8.5.68 Female observed laying on *Illigera platyandra* Dunn, four eggs were taken. Eggs are translucent white, smooth spherical and laid on the upper and undersides of the leaves. 0.75-0.8 mm.
- 12.5.68 All four eggs hatched early morning. Larva is hairy, single fine hairs which divide at the tip. The body is greyish in colour with a hint of green. The head is translucent and yellowish.
- 14.5.68 Entered 2nd. instar overnight. Larva 4 mm. long, head a definite yellow and the body is covered with very short pale hairs. It has taken on the 'Moby Dick' shape, the back being much darker greenish grey and flecked with tiny black spots.
- 17.5.68 Larva now 9 mm. long and has become much blacker on the back. The underside is a pale lime green.
- 18.5.68 Moulded overnight and now in the third instar, much darker.
- 19.5.68 Larvae now measure 13 mm. and 14.5 mm.
- 20.5.68 Moulded during afternoon, the larvae are now in their fourth instar. They are green with tiny black specks. Immediately after the moult one measured 17 mm.
- 24.5.68 Both larvae were 23 mm. long, commenced pupating during the evening. They spin a bed of silk first and then the girdle.
- 25.5.68 Both had completed pupation. They pupate head up on either side of the leaf but away from the light.
- 3.6.68 Both hatched this morning. They appear to have taken two days longer than normal, probably due to the cold spell.

The insect had not been recorded on Hong Kong Island since Walker but was seen by Packer on the south side of the Island on 27th April 1963."

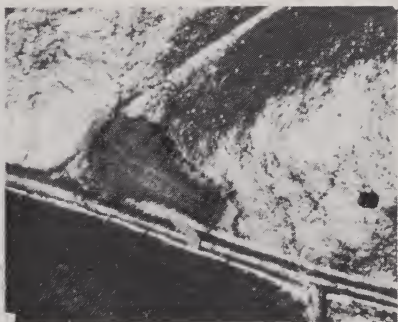


Fig. 1. *Lamproptera curius* egg on underside of food plant *Illigera platyandra*. 0.75-0.8 mm.

Fig. 2. *L. curius*, first instar.

Fig. 3. *L. curius*, first instar.

Fig. 4. *L. curius*, second instar, just after first moult.



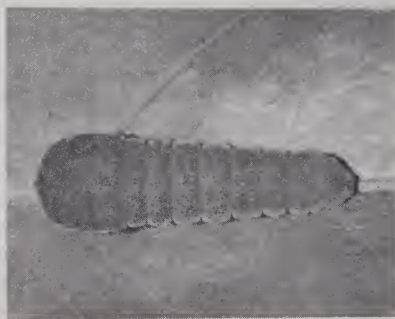
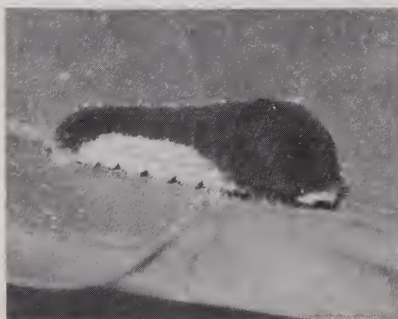


Fig. 5. *L. curius*, second instar, just after moult.

Fig. 6. Third instar.

Fig. 7. Third instar.

Fig. 8. Final instar.



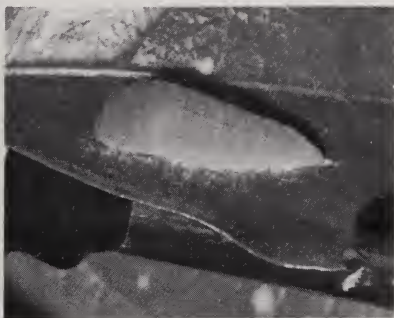


Fig. 9. *L. curius*, final instar.

Fig. 10. Pupating.

Fig. 11. Pupa.

Fig. 12. Pupa.

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## A PROPOSED TERMINOLOGY FOR THE TYPES OF DIAPAUSE OCCURRING IN THE ORDER LEPIDOPTERA

J. W. TILDEN

DIAPAUSE, A CONDITION OF SUSPENDED GROWTH and development, is frequent among animals, and serves the prime purpose of tiding the organism over unfavorable environmental conditions. Certain animals suspend activity in direct response to changes in stimuli such as temperature, then become active again as soon as normal conditions prevail. True diapause, however, is of a more complex nature.

The physiological cause of diapause is believed to be the temporary absence of the hormones of growth and development. This cessation of hormonal secretion is usually brought about by stimuli in the environment, such as changes of photoperiod, temperature, nutrition, and possibly humidity. In true diapause there is a lapse of time which is specific, before the secretory cells resume production of the hormones, so that the diapause lasts for some time. It is eventually ended, or broken, by another environmental stimulus, after which the production of hormones is resumed and growth and development continue.

An alternate explanation of diapause is that suggested by Roubaud, which postulates an inhibitory substance, produced by a sort of developmental fatigue. According to this hypothesis, this inhibitory substance is removed during diapause and growth resumes when all of the inhibitory factor is removed. This explanation seems to be based entirely on hypothesis. The explanation of the hormonal control of diapause, on the other hand, is supported by experimental data.

There may also exist a type of diapause that intervenes more or less automatically, as in the case of certain strains of the Silkworm, *Bombyx mori* (L.), which exists in univoltine, bivoltine, and tetravoltine strains. It should be mentioned, however, that external triggering stimuli have been reported for at least the bivoltine strain.

Diapause, once established as a part of the life history of a species, appears to be genetic, and a characteristic of that species. However, not all populations of a species need have identical types of diapause. Masaki, reporting on the Cabbage Moth, *Barathra brassicae* (L.), in Japan, found that the northern strains enter diapause on the basis of a short photoperiod. Southern strains enter a summer diapause on the basis of a long photoperiod, then the same strain enters a winter diapause when acted upon by the short photoperiod of the fall days.

Species without diapause may be regarded as of tropical origin, and to be imperfectly, or not at all, cold-adapted. Species with a true diapause fall into several groups, one treatment of which will be considered below.

Species without a diapause tend to be holodynamic and multivoltine. Species with a diapause are heterodynamic, but with a possibility of variable voltinism. In univoltine species there is always a diapause which not only carries the individuals over unfavorable conditions, but also serves the important function of synchronizing the individuals during the limited reproductive period. Bivoltine species, and possibly also certain multivoltine species, may be similarly synchronized in the first brood of the year.

Length of diapause varies greatly in different species. It may be but a few weeks, as in the arctiid moth *Arachnis picta* Pack., or last for the major part of the year, as in the eriocraniid moth, *Mnemonica cyanosparsella* Williams.

Diapause may occur in any stage of a life history. However, I have not found any instances of true diapause in adults of Lepidoptera.

In selecting terms to apply to the several types of diapause, I have used the root, *-pause*. The adjective *pausic* is used to denote a species that has a diapause. The adjective *apausic* is used to denote species without diapause. The root, *-pausic*, with certain prefixes, is used to qualify the various subsidiary types. It is proposed that diapause be classified under the following headings:

- I. *Apausic* species — without true diapause in any stage of development.
  - A. *Holodynamic* species — reproducing throughout the year. Such species must live where the climate is favorable all the year, or must move to a locality with favorable conditions upon the onset of unfavorable

weather. Such species are presumably of tropical origin. Such species, if they invade temperate and northern regions, can do so only during the warmer parts of the year. They either must move south with the coming of cold weather, or die. The migrations of the Monarch Butterfly, *Danaus plexippus* (L.), appear to involve this type of behavior.

- B. Pseudoheterodynamic species — tending to become inactive in the adult stage when they meet unfavorable conditions. Such insects may “hibernate” as adults, but return to normal activity when favorable conditions return. Examination of such adults indicates that they are not in true diapause. Rather, they exhibit a type of akinesis or suspended activity as a direct response to unfavorable conditions. If so-called hibernating individuals of *Nymphalis antiopa* (L.) are brought into a warm room, they return to activity in a short time. If placed in a refrigerator, they soon become inactive again. Such individuals can be alternately chilled and warmed a number of times without apparent permanent injury. It may be postulated that such are temperate species of ultimately tropical origin which have become adapted to cold conditions without developing a true diapause.

In the southwestern part of the United States, *Cynthia cardui* (L.) and *Cynthia annabella* Field behave similarly in the larval stage. If reared indoors at a standard temperature, *C. annabella* will reproduce holodynamically. Under outdoor conditions, the winter brood at San Jose, California, is longer or shorter in development in direct response to temperature. During the winter, larvae may be found in various instars.

II. Pausic species — with a true diapause in some stage of life history.

- A. Hiemopausic species — with diapause during the winter months.

As far as known, this type of diapause is triggered either by lowered temperature or by reduced photoperiod. Dawson (1931) found that if the last stage larvae of *Antheraea polyphemus* (Cramer) were exposed to reduced temperatures for about a week, the resulting pupae went into diapause. Williams (1946-



47) found that if pupae of *Hyalophora cecropia* (L.) were kept at a standard temperature the diapause lasted five months or more. If these pupae were chilled the diapause would break in a few weeks. Thus the diapause may be initiated by reduced temperature, and broken by a further cold shock. Williams found that brains of chilled pupae transplanted into unchilled pupae, caused the diapause of the unchilled pupae to break. It seems clear that the resumption of activity by the neurosecretory cells of the brain is responsible for the breaking of diapause in *Hyalophora*. It has been shown further that the brain hormone has an effect on the thoracic hormone, and the *Hyalophora* pupae, after coming out of diapause, went directly on to imaginal development.

The term, *thermopausic*, might be used for such instances where temperature is known to be the controlling stimulus.

Certain species have been found to enter diapause following reduced photoperiod. The Spruce Budworm, *Choristoneura fumiferana* (Clem.) has been found to do so. A rather interesting case is that of the bivoltine strain of *Bombyx mori*. Ovipositing females of this strain, if subjected to a long photoperiod, will lay diapausing eggs. The Oriental Fruit Moth, *Laspeyresia molesta* (Busck), enters diapause in response to reduced photoperiod. The northern populations of the Cabbage Worm, *Barathra brassicae* in Japan were found to do so by Masaki. The term *photopausic* might be useful to apply to species which have the diapause triggered by photoperiod, but as has been mentioned previously, not all of these would necessarily be *hiemopausic*.

Hibernation is a rather loose synonym of *hiemopause*, but as has been discussed above, certain species are said to hibernate when not in true diapause.

B. *Aestivopausic* species — with diapause during the warm part of the year.

This type of diapause seems to be frequent in the mediterranean climate of California, which is characterized by a winter rainy season, followed by a long dry season that lasts until the following fall. The triggering mechanism for summer diapause seems not to be known for many species. As noted above, Masaki found it to be lengthened photoperiod for the southern Japanese strain of the Cabbage Moth.



I have found rather numerous examples of summer diapause among moths in the San Francisco Bay region. *Coleophora viscidiflorella* Wlsm. diapauses inside its case during the summer. The arctiid *Arachnis picta* Pack. undergoes a larval diapause during the hotter part of the year, and when fall rains come, it pupates and soon emerges as an adult, without further feeding. The noctuid moth, *Dryotype opina* (Grt.), and a percentage of individuals of the geometrid *Prochoerodes truxaliata* (Gn.), have a long diapause in the pupal stage. Specimens of *Dryotype opina* that pupated in April and May emerged as adults in October, after the first fall rains. It must be pointed out that the triggering mechanism that initiates diapause has not been found for these species.

- C. Autopausic species — diapause apparently occurring automatically, the triggering mechanism either entirely genetic, or so far not known.

The univoltine strain of the Silk Moth has a diapause between each brood. It has been suggested that this occurs "automatically". If this be true, it should follow that it is a proprioceptive stimulus that triggers the diapause. However, in such species there may be another triggering stimulus that has so far escaped detection.

- D. Holopausic species — diapause very long, beginning in one season and lasting through one or more subsequent seasons. Neither triggering stimulus nor breaking stimulus clearly understood at present.

This category is more or less a matter of convenience, to include species not clearly belonging to any of the other groups, and presenting some characteristics that are different.

Species with a long diapause in the egg stage are included here. The Tailed Copper, *Lycaena arota* (Bdv.), lays its eggs in June. These do not hatch (in the sense of eclosion) until the following spring, though the larvae may develop in the shell some time before they eclose. Several species of *Satyrrium* (*Strymon* auct., part.) have rather similar life histories. It is noteworthy that the food plants of these species usually have fully grown, tough, unpalatable leaves at the time the eggs are laid, and that eclosion of the larvae coincides with the growth of tender leaves the following spring.

Several groups with long larval diapause are placed here. *Plebejus icarioides* (Bdv.), *Hesperia* spp., *Ochlodes* spp., and *Euphydryas* spp. may be mentioned. All of these agree in having

eggs that hatch soon after oviposition. The first instar larvae of some of these feed for a short time, then enter a diapause that lasts until the following spring, as in the case of *Euphydryas*. Or the larvae may diapause in the first instar, as is the case with *Ochlodes sylvanoides*.

*Mnemonica cyanosparsella* Williams, and apparently other members of this genus, present a remarkable condition. This species is dependent during its larval development on a critical stage in the growth of its food plant. As a larva it is a miner in the leaves of *Quercus agrifolia* Nee, the Coast Live Oak. The length of its larval development coincides with the period of new leaf growth. The egg stage is brief, the larval development rapid. The mature larva enters the soil and spins a cocoon in a cell there. The remaining ten months or so of the year are spent in diapause as a mature larva. The pupal period is quite short.

Certain species living in the sonoran and chihuahuan deserts present adaptations that are difficult to interpret. This may be because few workers have studied them in detail. The Lepidoptera of this region appear to have mechanisms that adjust their life cycles to the irregular summer rains that occur in this climate. The adults of certain species appear very shortly after rains. This would indicate that these species are in the pupal stage prior to the rains. Adults of certain other species appear some time after the rains. In some species this may be due to a diapause in the larval stage. *Euphydryas* is apparently facultatively double-brooded in parts of Arizona in certain seasons with exceptional rainfall.

In almost any region there are species that appear as adults on what has been termed a "time clock" basis. Such species emerge at nearly the same time each year regardless of weather, and may appear as adults during the driest season of the year. Some of these, such as the Agave-feeding *Agathymus*, feed in the larval stage on perennial plants little affected by ordinary changes in weather. Others, such as members of the genus *Hesperia*, feed on perennial grasses and are adjusted to the growth of these plants in relation to winter rainfall. Adults of *Hesperia harpalus* (Edw.) and *Apodemia mormo* (F. & F.), appear in the Inner Coast Ranges of California during the driest part of the year.

E. Nutripause species — diapause triggered by poor quality or reduced quantity of food.

Certain species have been found to enter diapause in re-

sponse to insufficient nutrition. Steinberg and Kamensky (1936) found that *Loxostege sticticalis* (L.) could be made to enter diapause by unfavorable nutrition, even when this occurred early in the life of the larvae. However, this diapause could be prevented if the temperature was kept above 32° C.

The study of diapause presents a number of complex and interesting problems. For example, strains of one species may have different types of diapause, and even in one strain, two types of diapause may occur, each with a different environmental stimulus as the trigger.

Summary: An attempt is made to explore some of the types of diapause found in the Lepidoptera, and to offer a tentative terminology by which to refer to them. It is certain that this attempt is subject to revision as more information is obtained. Nevertheless, it is hoped that this treatment will serve the useful purpose of providing a stimulus for future work.

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*URBANUS SIMPLICIUS* (STOLL),

A NEW RECORD FOR CALIFORNIA

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RECENTLY, MR. FRED THORNE SENT ME A SPECIMEN of a tailed skipper that proved to be *Urbanus simplicius* (Stoll). Mr. Thorne said that it had been brought to him in the San Diego Museum, by Mr. David Faulkner, who reported that the specimen was raised ex larva from garden beans at Solano Beach, about 25 miles north of San Diego.

Several larvae were reared. Four proved to be *Urbanus proteus* (Linnaeus). Only the one specimen of *U. simplicius* was obtained. This appears to be the first reported record of this species from California.

Continued from 14(4):233-252

25. *Dismorphia (Acmepteron) nemesis* (Latreille)

SPECIMENS: 2 ♂♂, 2 ♀♀; 3,400-4,800 feet; 26 Aug.-30 Oct.

As the preceding species, *D. nemesis* is local in distribution and uncommon in abundance, being found principally in the Montane Thicket and Elfin Woodland on Volcán San Martín Tuxtla (although one specimen was taken on Volcán Santa Marta). The behavior is similar to that of *D. euryope*. The body fluids smelled sour.

26. *Dismorphia (Enantia) albania* (Bates)

SPECIMENS: 2 ♂♂, 2 ♀♀; 700-1,800 feet; 14 July-25 Sept.

This pierid is uncommon; two specimens were taken in a coffee finca within the Semi-Evergreen Seasonal Forest and the other two along a margin of the Lower Montane Rain Forest. The flight is similar to that of *D. euryope* and *D. nemesis*. The body fluids smelled sour.

27. *Dismorphia (Enantia) jethys* (Boisduval)

SPECIMENS: 12 ♂♂, 1 ♀; 4,800-5,200 feet; 30 March-16 May.

*E. jethys* is locally abundant and found only above the canopy of the Elfin Woodland during the spring months. The flight is that of a typical pierid—rather rapid and erratic. The butterflies are attracted to flowers of the composite *Shistocarpha* sp. The body fluids of pinched specimens smelled sour.

## SUBFAMILY Pierinae

28. *Catasticta nimbice nimbice* (Boisduval)

SPECIMENS: 7 ♂♂, 11 ♀♀; 1,100-5,100 feet; 9 Feb.-30 Oct.

This species is locally abundant along the margins of the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest, and above the canopy of the Elfin Woodland. The flight is rather rapid, erratic, and usually of short duration, the butterflies alighting frequently on leaves ten to 15 feet above the ground. Only rarely was one individual encountered at a locality; thus, the species appears to be colonial. The body fluids of pinched specimens had a sour odor.

29. *Archonias (Archonias) tereas* (Hübner)

SPECIMENS: 3 ♂♂, 1 ♀; 1,000-2,450 feet; 4 Sept.-18 Nov.

*Archonias tereas* is locally common and found primarily in the Semi-Evergreen Seasonal Forest along stream bottoms on the southeast slopes of Volcán Santa Marta and in the Lower Montane Rain Forest along the fairly wide logging roads on the southern slopes of Volcán San Martín Tuxtla. The flight is very



slow, weak, and usually between two to six feet above the ground. The butterflies appear to be attracted to patches of *Boehmeria* sp., a plant that is common in disturbed areas within the rain forests. (As stated previously, this same plant is attractive to *Parides arcas mylotes*.) The body fluids of pinched individuals smelled slightly sour.

30. *Appias (Glutophrissa) drusilla poeyi* (Butler)

SPECIMENS: 9 ♂♂, 7 ♀♀; 500-2,400 feet; 23 April-26 July.

This species is abundant in Pastures, Recently Abandoned Milpas and in open, sunny glades within the Lower Montane Rain Forest. The flight is relatively rapid, erratic, and usually above ten feet of the ground. Adults are attracted to many species of flowering plants.

31. *Leptophobia aripa elodia* (Boisduval)

SPECIMENS: 7 ♂♂, 3 ♀♀; 1,100-5,200 feet; 6 Feb.-22 Nov.

This pierid is locally common and seen most frequently in and around the village of Ocotal Chico and above the canopy of the Elfin Woodland on Volcán Santa Marta. The flight is rapid, erratic, and usually above six feet of the ground.

32. *Itaballia (Itaballia) demophile calydonia* (Boisduval)

SPECIMENS: 5 ♂♂; 150 feet; 23 Aug.

This sulphur is locally common, all five specimens being taken in the *Bursera-Sabal-Orbignya* Associates of the Semi-Evergreen Seasonal Forest. When collected, the butterflies either were flying in shaded areas of the woodland or visiting the flowers of the nettle *Urera elata*. The flight is slightly slower and less erratic than that of most pierids but much like that of *Itaballia viardi* (species number 34). The males are endowed with small, yellowish, dorso-posterior abdominal scent glands that were everted when the butterflies were pinched and which emitted an acrid odor.

33. *Itaballia (Itaballia) pisonis kicaha* (Reakirt)

SPECIMENS: 12 ♂♂, 11 ♀♀; 0-2,450 feet; 15 July-17 Nov.

This dimorphic species is locally abundant in the Lower Montane Rain Forest (especially near Coyame) and Swamp Forest. The males have a rather slow flight that usually is between five and ten feet of the ground (similar to the flight of *I. demophile* and slower than that of *I. viardi*, species number 34). The females' flight is very slow, weak, and usually within two feet of the ground, a behavior that is very similar to that of the unrelated ithomiid *Aeria pacifica*. Indeed, I occasionally collected *I. pisonis*, *I. viardi*, and *A. pacifica* within an area of ten to 15 square feet and until the specimens were removed from the



net, I was unable to distinguish between the species. Of the 23 specimens collected, two males and one female exhibit a slight tendency towards the coloration of the opposite sex.

34. *Itaballia (Pieriballia) viardi viardi* (Boisduval)

SPECIMENS: 12 ♂♂, 9 ♀♀; 150-2,450 feet; 14 July-24 Sept.

This dimorphic species is locally abundant in the Lower Montane Rain Forest (especially in the vicinity of Coyame) and the *Bursera-Sabal-Orbignya* Associates of the Semi-Evergreen Seasonal Forest. Males have a fairly rapid and erratic flight that is similar to that of *I. demophile* and which usually is restricted to an area slightly beneath the forest canopy. However, the males occasionally descend to within five or ten feet of the ground in sunny glades. Females have a very slow and weak flight that very rarely is above two feet of the forest floor. As stated previously, this behavior is very similar to that of the sympatric ithomiid *Aeria pacifica*. Both males and females have abdominal scent glands that produce an acrid odor.

35. *Ascia (Ascia) monuste monuste* (Linnaeus)

SPECIMENS: 13 ♂♂, 8 ♀♀; 0-2,600 feet; 14 June-4 Sept.

The great southern white is abundant in Recently Abandoned Milpas, Pastures, the Littoral Woodland, and along road sides and most other relatively open, sunny areas (even in sunny glades within the Lower Montane Rain Forest). The flight is very rapid, erratic, and usually in excess of six feet of the ground. Adults visit the flowers of numerous plants.

36. *Melete isandra* (Boisduval)

SPECIMENS: 9 ♂♂, 7 ♀♀; 0-1,900 feet; 25 March-23 Oct.

*M. isandra* is locally abundant in Pastures and the small patches of Semi-Evergreen Seasonal Forest bordering Lago Catemaco, the Littoral Woodland, and in and around the village of Ocotál Chico, the butterflies being attracted to the cultivated flowers growing in the villagers' gardens. The flight is slightly slower than that of most medium to large pierids and usually between three and ten feet of the ground.

SUBFAMILY Coliadinae

37. *Colias (Zerene) cesonia* (Stoll)

SPECIMENS: 8 ♂♂, 9 ♀♀; 0-2,300 feet; 27 June-19 Sept.

The dog-face is abundant in Recently Abandoned Milpas and Pastures, and along sunny road sides in the vicinity of Lago Catemaco and common in most open, sunny areas in other sec-

tions of the Sierra. The flight is typical of most sulfurs and the butterflies very frequently visit flowers, particularly the composite *Melampodium kunthianum*, and mud puddles.

38. *Anteos clorinde* (Godart)

SPECIMENS: 8 ♂♂, 1 ♀; 700-1,100 feet; 20 June-30 Sept.

The clorinde is common in most open, sunny areas throughout the Sierra regardless of plant formation. The butterflies are attracted to moist earth. In the pastures surrounding Lago Catemaco I observed females ovipositing on *Cassia spectabilis*. The flight is rapid with powerful wing beats and usually in excess of five feet of the ground.

39. *Anteos maerula* (Fabricius)

SPECIMENS: 10 ♂♂, 1 ♀; 0-1,900 feet; 29 March-14 Sept.

The maerula is common throughout the Sierra in most open, sunny areas regardless of plant formation. The butterflies have behavioral characteristics similar to those of *A. clorinde*.

40. *Phoebis (Phoebis) sennae marcellina* (Cramer)

SPECIMENS: 21 ♂♂, 15 ♀♀; 0-1,500 feet; 8 June-18 Nov.

The cloudless sulphur is the most abundant species of large pierid in the Sierra and is found in practically all open, sunny regions regardless of plant formation. The flight is characteristic of most members of the genus—fast, erratic, and usually above six feet of the ground. The butterflies are attracted to mud puddles and numerous species of flowering plants. In the pastures surrounding Lago Catemaco I observed females ovipositing on *Cassia occidentalis*.

41. *Phoebis (Phoebis) philea* (Johansson)

SPECIMENS: 7 ♂♂, 11 ♀♀; 0-2,700 feet; 8 Feb.-13 Nov.

The orange-barred sulphur is common in practically all open, sunny sections of the range regardless of plant formation. The flight is similar to that of most members of the genus. The larval food plant is *Cassia occidentalis*.

42. *Phoebis (Phoebis) argante* (Fabricius)

SPECIMENS: 8 ♂♂, 16 ♀♀; 0-1,900 feet; 22 June-18 Nov.

The argante sulphur is abundant in the Littoral Woodland and in Recently Abandoned Milpas and Pastures in the vicinity of Lago Catemaco. The flight is similar to that of most species of *Phoebis*. The butterflies are attracted to mud puddles and to the flowers of a variety of plants.

43. *Phoebis (Phoebis) agarithe maxima* (Neumoegen)

SPECIMENS: 5 ♂♂, 3 ♀♀; 0-2,450 feet; 14 Aug.-24 Oct.

The large orange sulphur is abundant in the Littoral Wood-

land, Deciduous Woodland (including the *Pinus-Quercus* Associates), and Recently Abandoned Milpas and Pastures above elevations of 1,400 feet on the Santa Marta massif. Thus, this species is sympatric with the sibling *P. argante* over part of the Sierra (the coast) and allopatric with it over other sections, *P. argante* occupying the Catemaco Basin and *P. agarithe* occupying the slightly higher elevations of the range (particularly the Santa Marta massif).

44. *Phoebis (Phoebis) intermedia* Butler

SPECIMENS: 2 ♂♂ ; 2 mi. NE Catemaco, 1,100 feet, 3 Aug. 1962, 1 ♂ ; 1.25 mi. NE Ocotál Chico, 2,700 feet, 28 July 1963, 1 ♂.

This tailed sulphur is rare in the Sierra; one male was collected at a water hole assemblage of pierids on the shore of Lago Catemaco and the other as it flew over a sunny knoll in the *Pinus-Quercus* Associates of the Deciduous Woodland. The flight is similar to that of other species of *Phoebis*.

45. *Phoebis (Rhabdodryas) trite* (Linnaeus)

SPECIMENS: 2 ♂♂ ; 0, 1,100 feet; 26 June, 15 Aug.

Although only two specimens were collected, this species is locally common in the Sierra, being found principally at mud puddle assemblages of pierids along sunny road sides. The flight is rapid and erratic.

46. *Phoebis (Aphrissa) statira jada* (Butler)

SPECIMENS: 4 ♂♂ , 1 ♀ ; 0-1,100 feet; 8 June-14 Sept.

This species is locally common and found most frequently at mud puddle assemblages of pierids along sunny road sides. The flight is similar to that of other species of *Phoebis*.

47. *Eurema (Eurema) albula* (Cramer)

SPECIMENS: 8 ♂♂ , 4 ♀♀ ; 75-2,600 feet; 20 June-25 Oct.

This pierid is abundant along the margins of all forests and woodlands throughout the Sierra as well as in most pastures and fields containing some tree cover. The flight is rather slow, weak, and usually never near the ground—a characteristic flight of most species of *Eurema*. In pastures surrounding Lago Catemaco, I observed females ovipositing on *Picramnia andicola*, a very common small bush.

48. *Eurema (Eurema) दौरα दौरα* (Godart)

SPECIMENS: 20 ♂♂ , 19 ♀♀ ; 350-2,500 feet; 8 Feb.-19 Nov.

The fairy yellow is abundant in practically all open, sunny areas throughout the Sierra. The flight is the same as that of most members of the genus.

49. *Eurema (Eurema) boisduvaliana* Felder & Felder

SPECIMENS: 10 ♂ ♂, 4 ♀ ♀; 1,100-3,400 feet; 20 Feb.-30 Oct.

Boisduval's sulfur is common in Pastures, Recently Abandoned Milpas, and along sunny road sides in the vicinity of Lago Cate-maco and Ocotál Chico. The flight is typical of most members of the genus. The larval food plant is *Cassia occidentalis*. One of the four females collected is white instead of yellow.

50. *Eurema (Eurema) xanthochlora* (Kollar)

SPECIMENS: 14 ♂ ♂, 13 ♀ ♀; 500-4,100 feet; 17 March-29 Oct.

This pierid is locally common, being found principally along the margins of and just within the Lower Montane Rain Forest and the Semi-Evergreen Seasonal Forest. The flight is similar to that of most members of the genus. Sixteen of the 27 specimens collected were reared from chrysalids found on *Cassia fruticosa*, a small forest tree.

51. *Eurema (Eurema) mexicana* (Boisduval)

SPECIMENS: 9 ♂ ♂, 4 ♀ ♀; 500-2,700 feet; 9 March-16 Aug.

The Mexican sulphur is common in most open, sunny areas in the Sierra regardless of plant formation. The behavior is characteristic of most species of *Eurema*.

52. *Eurema (Eurema) salome* (Felder)

SPECIMENS: 1 ♂; Peak Volcán Santa Marta, 5,100 feet, 5 April.

The salome sulphur is rare, the single male being taken as it flew over the eastern rim of the crater of Volcán Santa Marta above the canopy of the Elfin Woodland. The wind was fairly strong at the time and so the possibility exists that the specimen was carried up the slopes of the volcano from lower elevations and perhaps even from the coast since *E. salome* usually is not considered a forest inhabitant.

53. *Eurema (Pyrisitia) proterpia* (Fabricius)

SPECIMENS: 10 ♂ ♂, 3 ♀ ♀; 0-2,600 feet; 9 March-23 Oct.

The proterpia orange is abundant in most open, sunny areas throughout the Sierra regardless of plant formation. The behavior is similar to that of most other species of *Eurema*. Three specimens collected in the early spring have the tails on the hind wings elongated, the black scales on the wing veins reduced, and the ventral hind wings mottled orange. This morphotype is named form *gundlachia* (Poey) and was until recently considered a distinct species.

54. *Eurema (Pyrisitia) lisa* Boisduval & Le Conte

SPECIMENS: 7 ♂♂, 9 ♀♀; 1,100-2,900 feet; 25 June-13 Nov.

The little sulphur is abundant in most open, sunny areas in the Sierra irrespective of plant formation, but especially in the Deciduous Woodland (including the *Pinus-Quercus* Associes). The behavior is typical for most members of the genus.

55. *Eurema (Pyrisitia) nise nelphe* (Felder)

SPECIMENS: 22 ♂♂, 9 ♀♀; 500-2,900 feet; 6 Feb.-25 Oct.

The nise sulphur is abundant (even more so than the sibling *E. lisa*) in most open, sunny areas throughout the range. Within the oak and pine-oak forests *E. nise nelphe* is the most common butterfly. The behavior is the same as that of most members of the genus.

56. *Eurema (Pyrisitia) dina westwoodi* (Boisduval)

SPECIMENS: 6 ♂♂, 8 ♀♀; 700-2,300 feet; 23 April-2 Aug.

This sulphur is abundant along the margins of the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest and in Pastures and along Hedgerows, particularly in the vicinity of Lago Catemaco. The butterflies seem to prefer partially shaded habitats. The larval food plant is *Picramnia andicola*, the same as that of *E. albula*. The flight is typical of most species in the genus.

57. *Eurema (Abaeis) nicippe* (Cramer)

SPECIMENS: 5 ♂♂, 2 ♀♀; 1,100, 1,900 feet; 8 June-21 July.

The sleepy orange is common in most open, sunny areas throughout the range, especially in Pastures and Recently Abandoned Milpas in the vicinity of Lago Catemaco. The larval food plant is *Cassia occidentalis*. The flight is slightly more rapid than that of most members of the genus.

58. *Nathalis iole* Boisduval

SPECIMENS: 4 ♂♂, 3 ♀♀; 1,100-2,100 feet; 21 June-14 Nov.

The dainty sulphur is locally common, being found principally in Recently Abandoned Milpas on the southern slopes of Volcán San Martín Tuxtla (elevation approximately 2,100 feet). The flight is more rapid and erratic than that of *Eurema* spp.



## FAMILY ITHOMIIDAE

## SUBFAMILY Ithomiinae

All of the 20 species of this subfamily recorded from the Sierra share several ecological and ethological characteristics. First, they all are shade-loving forest inhabitants, some species preferring relatively small patches of secondary forest and others the dark, dank, inner-most recesses of the mature montane forests. However, on cloudy days individuals often leave the forest cover and wander out into the fields and onto the road sides in the vicinity of the forests. Within the forests the species usually are rather colonial in that they are found in rather restricted areas instead of being scattered randomly throughout the plant formation. In addition, these colonies are non-specific, i.e., most of the species found within the given formation usually are found within the colony or "ithomiid assemblage" as it might better be termed. For the most part these "assemblages" are located in the dampest regions of the forest, e.g., in ravines, along streams, or near springs. Second, they all seem to be attracted to the blossoms of a few, non-related plants. These are *Tournefortia glabra* (a small, white-flowering tree that is locally common along the borders of the montane forests), *Eupatorium macrophyllum* (a purple-flowering annual or biennial that is common throughout the Sierra along the margins of and along the trails in the montane forests), and *Psychotria padifolia* (a small, white-flowering bush that is locally common within the interiors of the montane forests. When these plants are in blossom (summer and fall), I never encountered a plant that did not have a considerable number of ithomiids visiting it. In fact, most plants usually have several dozens of butterflies. (Ithomiids never were observed to be attracted to anything other than these four species of plants.) Third, the 20 species can be divided into two categories using flight behavior as a criterion. The first group includes the relatively small species with transparent wings (*Ithomia leila*, *I. patilla*, *Oleria zea*, *O. paula*, *Episcada artena*, *Pteronymia cottyto*, *Greta nero*, *G. oto*, *G. anetta*, and *Hypoleria cassotis*) and the yellow and black *Aeria pacifica*. These species fly very slowly with very weak wing beats; the flight usually is not over two to three feet above the forest floor. The second



group includes the slightly larger and the large species, all of which are black and orange and which may be termed the "tiger complex" (*Tithorea harmonia*, *Melinaea lilis*, *Mechanitis scada virginiana*, *Napeogenes tolosa*, and *Dircenna klugi*). These species have slightly more powerful flights that usually are between six and ten feet of the ground.

TRIBE Tithoreini

59. *Tithorea harmonia salvadoris* Staudinger

SPECIMENS: 7 ♂♂, 9 ♀♀; 0-1,400 feet; 9 May-7 Aug.

This species is locally abundant, the primary habitat being the Swamp Forest bordering Río Yougualtajapan on the coast; however, several localized colonies exist along other smaller streams and rivers on the Santa Marta massif (principally Río Guasuntlan below Soteapan).

TRIBE Melinaeini

60. *Melinaea lilis imitata* Bates

SPECIMENS: 16 ♂♂, 12 ♀♀; 0-3,200 feet; 10 June-17 Nov.

This ithomiid is locally common in the Lower Montane Rain Forest and Montane Rain Forest.

TRIBE Mechanitini

61. *Mechanitis polymnia lycidice* Bates

SPECIMENS: 20 ♂♂, 19 ♀♀; 0-2,700 feet; 25 June-24 Oct.

*M. polymnia lycidice* and the two sibling species *M. egaensis doryssus* and *M. menapis saturata* are locally abundant and sympatric over most of the Sierra (see *M. menapis saturata* for possible exception), being found in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest including the *Bursera-Sabal-Orbignya* Associates, and Swamp Forest.

62. *Mechanitis egaensis doryssus* Bates

SPECIMENS: 19 ♂♂, 9 ♀♀; 0-2,450 feet; 1 July-17 Nov.

This species is locally abundant in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest including the *Bursera-Sabal-Orbignya* Associates, and Swamp Forest.

63. *Mechanitis menapis saturata* Godman

SPECIMENS: 6 ♂♂, 9 ♀♀; 75-3,100 feet; 17 March-5 Sept.

This species is locally common and is found in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest. The butterflies seem to prefer the mature montane forests over the more disturbed and

less dense ones, as for example in the Catemaco Basin. However, the possibility exists that the species simply was overlooked at many localities because of its close resemblance to the two sibling species.

TRIBE Napeogenini

64. *Hypothyris lycaste dionaea* Hewitson

SPECIMENS: 19 ♂♂, 5 ♀♀; 0-3,400 feet; 17 June-17 Nov.

This ithomiid is locally abundant in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest. The butterflies seem to prefer the less disturbed forests.

65. *Napeogenes tolosa* (Hewitson)

SPECIMENS: 14 ♂♂, 14 ♀♀; 0-3,000 feet; 18 March-17 Nov.

*Napeogenes tolosa* is locally abundant in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest including the *Bursera-Sabal-Orbignya* Associates, and Swamp Forest. The butterflies appear to prefer the more mature forests.

TRIBE Ithomiini

66. *Ithomia leila* Hewitson

SPECIMENS: 22 ♂♂, 1 ♀; 1,100-4,450 feet; 25 June-30 Oct.

This species is locally common in the Lower Montane Rain Forest, Montane Rain Forest, Montane Thicket, and Semi-Evergreen Seasonal Forest. The butterflies seem to prefer mature forests at medium and high elevations.

67. *Ithomia patilla* Staudinger

SPECIMENS: 25 ♂♂, 5 ♀♀; 0-2,700 feet; 22 June-17 Nov.

*I. patilla* is locally abundant in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest. The species seems to prefer relatively undisturbed forests at low and medium elevations.

TRIBE Oleriini

68. *Hyposcada virginiana virginiana* (Hewitson)

SPECIMENS: 2 ♂♂, 1 ♀; 9 mi. ENE Sontecomapan, 0 feet, 17 Nov. 1962, 1 ♂; 5 mi. E Cuetzalapan, 2,450 feet, 4 Sept. 1962, 1 ♂; 4.5 mi. ESE Cuetzalapan, 2,500 feet, 5 Sept. 1962, 1 ♀.

This species is rare; all three specimens were collected in the Lower Montane Rain Forest.

69. *Oleria zea* (Hewitson)

SPECIMENS: 6 ♂♂, 2 ♀♀; 4,200-4,800 feet; 7 April-16 July.

*O. zea* is common only in several ravines in the Montane Thicket on Volcán Santa Marta.

70. *Oleria paula* (Weymer)

SPECIMENS: 13 ♂♂, 17 ♀♀; 0-4,300 feet; 11 Feb.-17 Nov.

This ithomiid is locally abundant in the Lower Montane Rain Forest, Montane Rain Forest, Montane Thicket, Semi-Evergreen Seasonal Forest including the *Bursera-Sabal-Orbignya* Associes, and Swamp Forest.

71. *Aeria pacifica* Godman & Salvin

SPECIMENS: 11 ♂♂, 8 ♀♀; 0-3,000 feet; 17 March-5 Oct.

This yellow and black ithomiid is locally common in the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest. The species seems to prefer relatively undisturbed forests.

TRIBE Dircennini

72. *Dircenna klugi* (Geyer)

SPECIMENS: 17 ♂♂, 20 ♀♀; 0-4,200 feet; 17 March-17 Nov.

This large and relatively transparent species is abundant in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest.

73. *Episcada artena* (Hewitson)

SPECIMENS: 11 ♂♂, 12 ♀♀; 1,650-4,600 feet; 20 June-29 Oct.

This species is locally common in the Lower Montane Rain Forest, Montane Rain Forest including the *Liquidambar-Quercus* Associes, Montane Thicket, Semi-Evergreen Seasonal Forest, and Hedgerows. The butterflies seem to prefer the less disturbed forests at medium and high elevations.

74. *Pteronymia cottyto* (Guérin)

SPECIMENS: 16 ♂♂, 11 ♀♀; 75-5,100 feet; 30 March-24 Oct.

*P. cottyto* is one of the most abundant and the most widespread ithomiid in the Sierra; the butterflies are found in practically all shaded and semi-shaded areas throughout the range regardless of plant formation.

TRIBE Godyridini

75. *Greta nero* (Hewitson)

SPECIMENS: 13 ♂♂, 20 ♀♀; 700-4,450 feet; 7 April-29 Oct.

This species is one of the most abundant ithomiids in the Sierra and is found in the Lower Montane Rain Forest, Montane Rain Forest, Montane Thicket, and the Semi-Evergreen Seasonal Forest.

76. *Greta oto* (Hewitson)

SPECIMENS: 16 ♂♂, 20 ♀♀; 1,100-4,300 feet; 17 March-13 Sept.

*Greta oto* is one of the most abundant species of ithomiid in the range and is found in the Lower Montane Rain Forest, Montane Rain Forest including the *Liquidambar-Quercus* Associates, Montane Thicket, and Semi-Evergreen Seasonal Forest.

77. *Greta anetta* (Guérin)

SPECIMENS: 24 ♂♂, 15 ♀♀; 2,900-4,750 feet; 15 June-25 Oct.

This species is locally abundant in the Montane Rain Forest, Montane Thicket, and Elfin Woodland.

78. *Hypoleria cassotis* (Bates)

SPECIMENS: 14 ♂♂, 8 ♀♀; 0-2,900 feet; 3 July-30 Oct.

This ithomiid is locally common in the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest. The butterflies seem to prefer dank areas more than the other species in the family.

## FAMILY DANAIDAE

## SUBFAMILY Danainae

79. *Danaus (Danaus) plexippus plexippus* (Linnaeus)

SPECIMENS: 3 ♂♂, 3 ♀♀; 1,100-2,200 feet; 8 Feb.-26 Sept.

The monarch is common in most open, sunny areas only during fall and winter. The butterflies are attracted to the orange blossoms of *Asclepias tuberosa*, a plant that is abundant in the fields and pastures surrounding Lago Catemaco. The butterflies have a soaring flight.

80. *Danaus (Tasitia) gilippus strigosus* (Bates)

SPECIMENS: 8 ♂♂, 8 ♀♀; 0-1,900 feet; 19 May-23 Oct.

The queen is common in most open, sunny areas, but principally in Recently Abandoned Milpas and Pastures. Adults are attracted to the blossoms of *Asclepias tuberosa*, *A. woodsoniana*, *Heliotropium indicum*, and *Lantana camara*, all of which are common field plants. The butterflies have a soaring flight that usually is somewhat lower than that of *D. p. plexippus*.

81. *Danaus (Tasitia) eresimus montezuma* Talbot

SPECIMENS: 3 ♂♂, 2 ♀♀; 1,100, 2,200 feet; 21 Aug.-15 Oct.

The *eresimus* is uncommon and found in Recently Aban-

doned Milpas and Pastures. All specimens were taken as they fed on flowering plants—*Cordia spinescens* and *Bidens pilosa* var. *bimucronata*. The flight is similar to that of the queen.

#### SUBFAMILY *Lycoreinae*

##### 82. *Lycorea ceres atergatis* (Doubleday)

SPECIMENS: 17 ♂♂, 10 ♀♀; 0-2,450 feet; 27 June-23 Oct.

This species is locally common, being found along the margins of and just within the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest; in addition, the species is found in Pastures and Recently Abandoned Milpas when forest cover is near. The flight of this unusually marked danaid is slower than that of the other three members of the family but similar to that of the larger ithomiids ("tiger complex") and the heliconians. Adults are attracted to the purple flowers of *Heliotropium indicum*, a common plant in the fields and pastures throughout the Sierra. In addition, adults were collected on the blossoms of *Cordia spinescens*, *Eupatorium macrophyllum*, and *E. pittieri*. As described previously, the latter two plant species are also attractive to the ithomiids. Indeed, on several occasions I observed *L. ceres atergatis* and several species of ithomiids feeding on a single flower head of *E. macrophyllum*. Thus, in addition to resembling several of the ithomiids, heliconians, and pierids in morphology and wing coloration, *L. ceres atergatis* resembles those species also in ecology and ethology.

#### FAMILY SATYRIDAE

##### SUBFAMILY *Satyrinae*

##### 83. *Pierella luna heracles* Boisduval

SPECIMENS: 6 ♂♂, 1 ♀; 800-2,300 feet; 20 June-27 Aug.

This satyrid is common in most of the forested regions, particularly in the Lower Montane Rain Forest, Montane Rain Forest including the *Liquidambar-Quercus* Associates, and Semi-Evergreen Seasonal Forest including the *Bursera-Sabal-Orbigyna* Associates. The butterflies seem to prefer flying up and down the forest trails; very few individuals were seen off trails. The flight is slow, usually never more than one foot above the ground, and



of short duration—the butterflies alighting mainly on fallen leaves.

84. *Taygetis mermeria excauata* Butler

SPECIMENS: 3 ♂♂; 2,000, 3,000 feet; 12 April, 31 May.

This large species is uncommon and local; all three specimens were collected as they rested on the ground in coffee fincas in partially cleared Lower Montane Rain Forest on the Santa Marta massif. All specimens represent the morphotype that has been named form *tenebrosus* Blanchard.

85. *Taygetis virgilia* (Cramer)

SPECIMENS: 3 ♂♂, 1 ♀; 1,100, 1,950 feet; 29 June-12 Nov.

This satyrid is uncommon and found in the Semi-Evergreen Seasonal Forest and the *Pinus-Quercus* Associates of the Deciduous Woodland. The flight is relatively slow, very close to the ground, and usually of short duration. Although the butterflies are found most frequently along trails, they do not adhere to these as tenaciously as does *Pierella luna*.

86. *Taygetis andromeda* (Cramer)

SPECIMENS: 10 ♂♂, 3 ♀♀; 0-2,900 feet; 17 March-18 Nov.

*T. andromeda* is common in the Lower Montane Rain Forest, Montane Rain Forest including the *Liquidambar-Quercus* Associates, Semi-Evergreen Seasonal Forest, and Swamp Forest. The species is the most common satyrid in the mature rain forests. The behavior is similar to that of *T. virgilia*.

87. *Taygetis keneza* Butler

SPECIMENS: 17 ♂♂, 6 ♀♀; 800-2,400 feet; 20 June-19 Nov.

This species is common in the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest. The behavior is similar to that of *T. virgilia*.

88. *Taygetis kerea* Butler

SPECIMENS: 5 ♂♂, 3 ♀♀; 1 mi. SSE Ocotil Chico, 1,800 feet, 23 Oct. 1962, 2 ♂♂, 2 ♀♀: Ocotil Chico, 1,900 feet, 24 Oct. 1962, 1 ♂: 1 mi. ENE Ocotil Chico, 2,100 feet, 23 Oct. 1962, 2 ♂♂; 24 Oct. 1962, 1 ♀.

This species is locally common; all specimens were taken in the Deciduous Woodland and the *Pinus-Quercus* Associates on several ridge slopes where the grass was between one and three feet in height. The behavior is similar to that of *T. virgilia*. *Taygetis kerea* was recorded from Mexico previously only from Chiapas and the "Sierra Madre del Sur" (Hoffmann, 1940).

89. *Euptychia gemma freemani* (Stalings & Turner)

SPECIMENS: 19 ♂♂, 11 ♀♀; 350-2,700 feet; 8 Feb.-29 Oct.



The gemmed satyr is abundant in the grassy areas in the Savanna and the Deciduous Woodland (including the *Pinus-Quercus* Associates), on the Santa Marta massif. However, although the species is confined almost exclusively to these formations, several individuals were collected in the northwestern section of the range. Two were collected in grassy fields on ridges and one on the lawn of the Hotel Playa Azul. This last locale seems to be foreign to the species and I think that the specimen's occurrence there is the result of the previous day's weather condition (high northeast winds). Thus, the possibility exists that the butterfly is a stray blown down from higher and more suitable habitats.

90. *Euptychia hesione* (Sulz)

SPECIMENS, 11 ♂♂, 1 ♀; 0-2,100 feet; 8 Feb.-23 Oct.

This satyrid is abundant in the Semi-Evergreen Seasonal Forest including the *Bursera-Sabal-Orbigyna* Associates, Swamp Forest, Lower Montane Rain Forest, and along Hedgerows. The species seems to prefer relatively disturbed forests. The flight is characteristic of most members of the genus—rather slow, usually between one and two feet of the ground, and of short duration, the butterflies alighting frequently on vegetation.

91. *Euptychia metaleuca* (Boisduval)

SPECIMENS: 5 ♂♂, 4 ♀♀; 0-3,000 feet; 9 Feb.-5 Sept.

This satyrid is locally common in the Lower Montane Rain Forest, Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest. The butterflies seem to prefer relatively undisturbed forests. The behavior is similar to that of most other members of the genus.

92. *Euptychia mollina* Hübner

SPECIMENS: 6 ♂♂, 8 ♀♀; 900-4,100 feet; 8 Feb.-5 Oct.

*E. mollina* is common throughout most of the Sierra and found principally in the Semi-Evergreen Seasonal Forest, Deciduous Woodland including the *Pinus-Quercus* Associates, Lower Montane Rain Forest, and along Hedgerows. The flight usually is approximately three to four feet above the ground and hence slightly higher than that of most species of *Euptychia*.

93. *Euptychia labe* Butler

SPECIMENS: 3 ♂♂, 5 ♀♀; 500-3,300 feet; 26 May-25 Oct.

This species is local and uncommon, being found in the Semi-Evergreen Seasonal Forest, Lower Montane Rain Forest, and Montane Rain Forest including the *Liquidambar-Quercus* Associates. The flight is typical of most members of the genus.

94. *Euptychia similis* Butler

SPECIMENS: 2 ♂♂, 1 ♀; 1 mi. NNE Ocotal Chico, 2,100 feet, 14 June 1963, 2 ♂♂: 2 mi. NE Catemaco, 1,100 feet, 24 June 1962, 1 ♀.

This species is rare, although because of its close similarity to *E. themis* and *E. undina*, both of which may be only morphotypes of *E. similis*, additional butterflies may have been overlooked. The two males were collected along a wide trail in the *Liquidambar-Quercus* Associates of the Montane Rain Forest and the single female along the margin of a section of the Semi-Evergreen Seasonal Forest bordering Lago Catemaco. The behavior is similar to that of most members of the genus.

95. *Euptychia themis* Butler

SPECIMENS: 19 ♂♂, 1 ♀; 0-2,700 feet; 20 Feb.-13 Nov.

This satyrid is common in and along the margins of all forests except the Montane Thicket and Elfin Woodland. The behavior is typical of most members of the genus.

96. *Euptychia undina* Butler

SPECIMENS: 6 ♂♂, 9 ♀♀; 150-3,000 feet; 10 June-10 Nov.

*E. undina* is common and found in and along the margins of the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, Montane Rain Forest including the *Liquidambar-Quercus* Associates, and Swamp Forest. Although the species is sympatric with *E. themis* over most of the Sierra, *E. undina* seems to prefer less disturbed areas than *E. themis*.

97. *Euptychia disaffecta* Butler & Druce

SPECIMENS: 19 ♂♂, 6 ♀♀; 750-3,400 feet; 8 Feb.-30 Oct.

This species is locally abundant and found principally in grass fields within the *Liquidambar-Quercus* Associates of the Montane Rain Forest. The behavior is typical of most species of *Euptychia*.

98. *Euptychia hermes sosybius* (Fabricius)

SPECIMENS: 15 ♂♂, 5 ♀♀; 1,100-2,200 feet; 6 Feb.-13 Nov.

The Carolina satyr is the most abundant and most widely distributed satyrid in the Sierra; the butterflies are found in all shaded and partially shaded areas except the interiors of the montane forests. The behavior is similar to that of most members of the genus.

99. *Euptychia gigas* Butler

SPECIMENS: 8 ♂♂, 8 ♀♀; 800-2,300 feet; 23 Oct.-20 Nov.

This satyrid is locally common, being found in the Deciduous Woodland (including the *Pinus-Quercus* Associates) and several

small patches of Semi-Evergreen Seasonal Forest fringing Lago Catemaco. The butterflies were collected only during the fall months. Within the oak and pine-oak communities, *E. gigas* was taken most frequently in tall grassy areas on the slopes of several ridges.

100. *Euptychia libye* (Linnaeus)

SPECIMENS: 9 ♂ ♂, 4 ♀ ♀; 0-2,800 feet; 11 Feb.-19 Nov.

*E. libye* is common in most forests, particularly the Semi-Evergreen Seasonal Forest, Lower Montane Rain Forest, Swamp Forest, and the Deciduous Woodland (including the *Pinus-Quercus* Associates). The flight is similar to that of most members of the genus.

101. *Euptychia glaucina* Bates

SPECIMENS: 1 ♂, 6 ♀ ♀; 150-2,900 feet; 23 June-24 Oct.

This satyrid is uncommon and found primarily in coffee fincas within the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest. The behavior is typical of the group.

102. *Euptychia sericella* Bates

SPECIMENS: 17 ♂ ♂, 2 ♀ ♀; 1,800-2,700 feet; 13 April-25 Oct.

This iridescent species is locally abundant in the Semi-Evergreen Seasonal Forest and the *Liquidambar-Quercus* Associates of the Montane Rain Forest. Within these formations the butterflies are restricted to the relatively open, tall grassy areas. The behavior is typical of most *Euptychia* spp.

103. *Euptychia* sp. near *alcinoe* Felder

SPECIMENS: 6 ♂ ♂; 1,100, 1,800 feet; 30 June-13 Nov.

This species, which thus far remains undertermined because of the specimens' poor condition, is local and uncommon; all specimens were collected in disturbed sections of Semi-Evergreen Seasonal Forest. The behavior is similar to that of other species in the genus.

104. *Pedaliodes pisonia circumducta* (Thieme)

SPECIMENS: 5 ♂ ♂, 2 ♀ ♀; 4,300-5,000 feet; 5 April-3 Aug.

This species is locally common in the Elfin Woodland on Volcán Santa Marta. The butterflies occur in the small, restricted grassy and shrubby areas that exist on several of the upper ridges where sunlight is able to reach the ground. The flight is slightly faster and more powerful than that of most species in the family.

105. *Dioriste tauropolis* (Doubleday & Hewitson)

SPECIMENS: 20 ♂ ♂; 2,400-5,400 feet; 23 Feb.-30 Oct.

This brightly colored satyrid is locally abundant in the Montane Thicket and Elfin Woodland. The butterflies were collected most frequently in sunlit patches of forest as they rested on leaves or as they chased one another. The flight is quicker, more erratic, and usually not as low to the ground as that of most satyrids but very similar to that of the pierids *Dismorphia euryope* and *D. nemesis*, both of which are sympatric with *Dioriste tauropolis*.

#### SUBFAMILY Brassolinae

106. *Opsiphanes* (*Opsiphanes*) *boisduvalii* Westwood & Hewitson

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 5 Oct. 1962.

This species is rare; the single specimen was collected as it imbibed fermenting sap oozing from the trunk of a citrus tree in a pasture near Hotel Playa Azul.

107. *Opsiphanes* (*Opsiphanes*) *cassiae castaneus* Stichel

SPECIMENS: 5 ♂ ♂, 8 ♀ ♀; 800, 1,100 feet; 20 March-3 Oct.

This species is common only in Pastures in the Catemaco Basin. The butterflies were collected most frequently as they fed on sap oozing from the trunks of citrus trees. The flight is extremely rapid with powerful wing beats. The androconia on the hind wings and abdomens of males produce a sweetish odor.

108. *Eryphanis aescacus* (Herrich-Schaeffer)

SPECIMENS: 2 ♂ ♂; 2.5 mi. SW Sontecomapan, 800 feet, 16 July 1962, 1 ♂; 2 mi. SW Sontecomapan, 900 feet, 3 Nov. 1962, 1 ♂.

*E. aescacus* is rare in the Sierra. Both specimens were collected along the margins of the Lower Montane Rain Forest; one was imbibing moisture from a rotting corn cob and the other was resting on the trunk of a small tree.

109. *Caligo memnon* (Felder)

SPECIMENS: 8 ♂ ♂, 6 ♀ ♀; 0-1,800 feet; 15 March-20 Nov.

This large species is common in most of the forests at relatively low altitudes, particularly the Semi-Evergreen Seasonal Forest including the *Bursera-Sabal-Orbigyna* Associates, Lower Montane Rain Forest, Swamp Forest, and Littoral Woodland. The butterflies are primarily crepuscular—during the day they rest on tree trunks but at dusk they fly up and down the forest paths and even venture out onto the road sides and into pastures and fields. The flight is rapid, undulating, and usually between

two and six feet of the ground. The androconia on the hind wings and abdomens of males produce a sweet odor.

110. *Caligo uranus* Herrich-Schaeffer

SPECIMENS: 5 ♂♂, 2 ♀♀; 900-2,800 feet; 7 April-? Nov.

This brilliantly marked *Caligo* is uncommon and found primarily in the Lower Montane Rain Forest and Montane Rain Forest during late summer and fall. The behavior is similar to the related species *C. memnon*.

FAMILY NYMPHALIDAE

SUBFAMILY Amathusiinae

TRIBE Morphini

111. *Morpho theseus justiciae* Salvin & Godman

SPECIMENS: 7 ♂♂; 2,450 feet, 4,300 feet; 4-17 April.

This species is abundant in the Montane Rain Forest, Montane Thicket, and Elfin Woodland only during the spring and fall months. Therefore, the species apparently is double brooded with a relatively long life cycle. The butterflies have a slow, undulating flight that usually is above the forest canopy. Individuals rarely entered shaded areas; this behavior also was noted by Welling (1966) in Oaxaca. The majority of the specimens were collected on a sunny, open ridge on the upper slopes of Volcán Santa Marta. The slopes of this ridge are covered with heavy montane rain forest and so the butterflies glided above the canopy up one slope and down the other, crossing the open ridge top in the process. By positioning myself in an inconspicuous place on the crest (the butterflies have a keen sense of sight and usually reverse flight direction when they detect conspicuous movements), I was able to net several individuals as they glided past. The subspecies *justiciae* is represented in the Sierra by an endemic blue form that has been named *schwezeeri* Le Moult & Real but which probably should be considered a distinct subspecies because of its geographic isolation.

112. *Morpho polyphemus luna* Butler

SPECIMENS: 26 ♂♂, 6 ♀♀; 1,600-4,800 feet; 16 July-1 Oct.

This white *Morpho* is abundant in the Elfin Woodland, Montane Thicket, and Montane Rain Forest only in late summer and



fall. The species first appears at the highest elevations in early or mid July. Then as the season progresses, the range is extended so that individuals become more and more common at slightly lower elevations. By September and October the butterflies are seen occasionally at elevations slightly below 2,000 feet, that is, when mature rain forest is present. The flight is similar to that of the preceding species with the exception that *M. polyphemus luna* glides more frequently and does not hesitate to fly beneath the forest canopy (at which times the butterflies often descend to within five or ten feet of the ground).

113. *Morpho peleides montezuma* Guénée

SPECIMENS: 28 ♂♂, 1 ♀; 0-5,100 feet; 9 Feb.-19 Oct.

The peleides morpho is common at relatively low elevations and found in or along the margins of all formations except the Montane Thicket and Elfin Woodland. The butterflies seem to prefer sunny trail and glades within relatively disturbed forests. The flight is more rapid than that of the preceding two species and usually between two and five feet of the ground.

SUBFAMILY Acraeinae

TRIBE Acraeini

114. *Actinote leucomelas* (Bates)

SPECIMENS: 3 ♂♂, 15 ♀♀; 1,100-4,800 feet; 12 March-17 April, 10 Oct.-18 Nov.

*Actinote leucomelas* is locally and seasonally common, being found along the margins of the Semi-Evergreen Seasonal Forest, Lower Montane Rain Forest, the *Pinus-Quercus* Associates of the Deciduous Woodland, Montane Rain Forest, and Montane Thicket during the spring and fall months. Within the pine-oak forest, the butterflies were collected frequently on the flowers of the composite *Bidens pilosa* var. *bimucronata*. The flight is slow, weak, and usually between 12 and 20 feet of the ground. Larvae were found on *Liabum dimidium*, an uncommon shrub along small streams below the village of Ocotil Chico.

115. *Actinote guatemalena veraecruzis* Jordan

SPECIMENS: 5 ♂♂, 13 ♀♀; 0-2,700 feet; 10 Feb.-17 May.

This species is common in the Deciduous Woodland and the *Pinus-Quercus* Associates only during the spring months. The butterflies are attracted to the white blossoms of *Vernonia leiocarpa*, a common composite in the pine-oak and oak communities. The flight is relatively slow, weak, and usually between ten and 15 feet above the ground.

(to be continued)

## NOTICES

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**ADDRESS CORRECTION:** Kurt Johnson, author of "Post Pleistocene Environments and Montane Butterfly Relicts on the Western Great Plains" in volume 14, number 4 of the Journal: Dept. of Biology, City University of New York, City College, Convent Ave. and 138th Street, New York, NY 10031.

**PUBLICATIONS:** Moths of Southern Africa. E. C. G. Pinhey, Tafelberg Publishers Ltd., 28 Wale St., Cape Town, South Africa. Available in U. S. A. from Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, CA 90007. \$35.95.

Butterflies of West Malaysia and Singapore, Vol. 1 and 2. W. A. Fleming, E. W. Classey Limited, Park Road, Faringdon, Berkshire, England. Available in U. S. A. from E. R. S. (above). \$47.00 set.

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# THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

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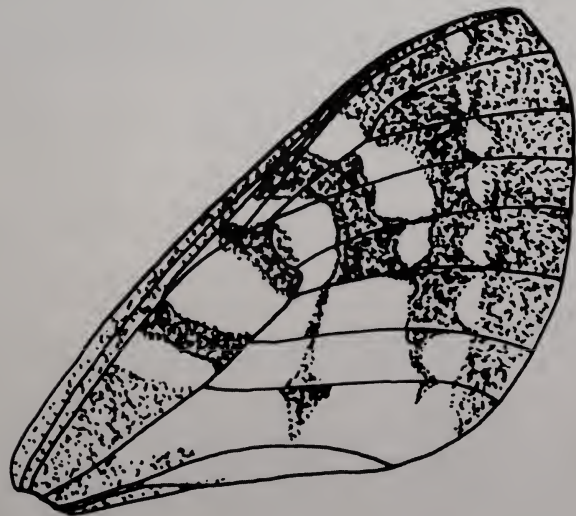
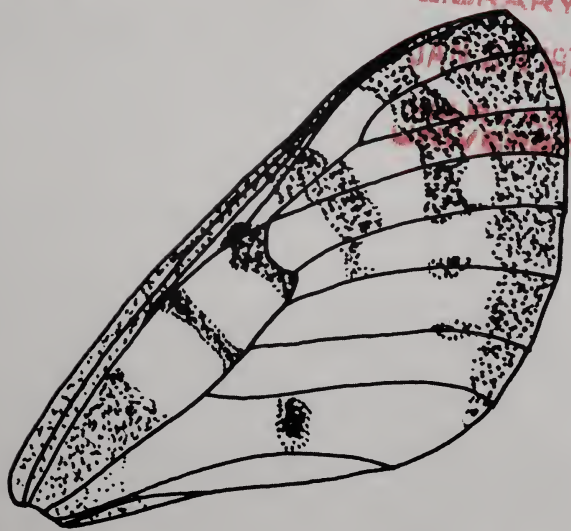
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A NOTE ON THE SUBSPECIES OF  
*PARNASSIUS CLODIUS* MENETRIES

FOUND IN THE ROCKY MOUNTAINS OF THE UNITED STATES  
(PAPILIONIDAE)<sup>1</sup>

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CONSIDERABLE CONFUSION EXISTS in the nomenclature associated with the genus *Parnassius* in North America. Further confusion was generated recently by the treatment of *Parnassius clodius* Ménétries in Howe, 1975. The purpose of this note is to differentiate clearly the three principal races of *P. clodius* found in the Rocky Mountains of the United States prior to further publication in a forthcoming book on butterflies of that region. John F. Emmel of Hemet, California is undertaking a study of the entire *clodius* complex for subsequent publication. The three taxa discussed in detail here are: *menetriesii* H. Edwards, *gallatinus* Stichel, and *altaurus* Dyar.

The nomenclatural problem first began in the mid-1800's when Boisduval published the name of the asiatic species *clarius* Eversmann in a preliminary list of California butterflies. This error was corrected in his 1869 list. In supplying information to W. H. Edwards for his Butterflies of North America series, Henry Edwards also used the name *clarius* to represent a race of *clodius*. In 1877, Henry Edwards recognized his error and described *menetriesii*. This action, however, did not put the problem to rest, as Edwards's specimens included what we now recognize as two subspecies: *baldur* Edwards and *menetriesii* in a restricted sense. The type series for *menetriesii* comprised specimens from California: Bear Valley in the Sierra Nevada,

<sup>1</sup>Published with the approval of the Director, Wyoming Agricultural Experiment Station as Journal Article no. JA 832.

<sup>2</sup>Research Associate, Allyn Museum of Entomology, Sarasota, Florida; Museum Associate, Natural History Museum of Los Angeles County, Los Angeles, California.

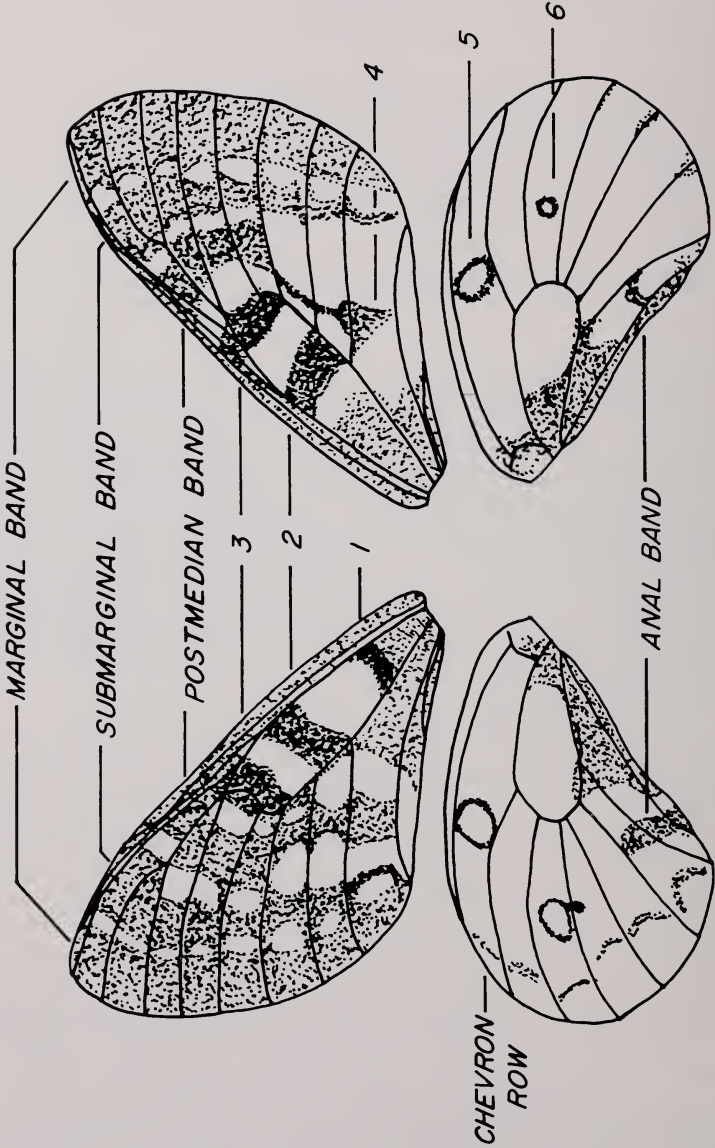


Fig. 1.—Maculation and spot designation in *Parnassius clodius*; male right, female left. *P. c. altaurus* is figured.

Lake Tahoe, Downieville collected by H. Behr and H. Edwards, and a female from Mt. Nebo, Utah, collected by I. D. Putnam. In his description of *menetriesii*, Henry Edwards cited the wide variation among the specimens in the type series and no holotype was designated. The name *baldur* was applied by William Henry Edwards in 1877 to specimens from the Sierra Nevada (see Brown, 1975 for further discussion).

In 1918, Barnes and McDunnough recognized the mixed series used in describing *menetriesii* and applied the name *in sensu stricto* to the female specimen from Utah. When Felix Bryk published his *Parnassius* monograph in "Das Tierreich" in 1935, he made a hopeless muddle of *clodius* in spite of the Barnes and McDunnough paper and an earlier paper by Skinner (1916). McDunnough, 1936, published extensive corrections to Bryk's work, but these appear to have been overlooked by most recent workers.

Figure 1 shows the general maculation found in *Parnassius clodius*. The specimens shown are *P. clodius altaurus*. In the ensuing descriptions, references are to the characters delineated in this figure.

### *P. CLODIUS MENETRIESII* H. EDWARDS, 1877

This insect ranges from eastern Utah into southwest Wyoming where it intergrades into *gallatinus*. It is the most lightly marked of the three subspecies under discussion. The HW spots (5, 6) are red and not yellow as shown in Howe, 1975 (pl. 78, f. 18). In the males, the cell spots (2, 3) are quite narrow and the postmedian dark band is restricted to the post-cell area. Spot 4 is small, rounded and restricted to cell  $Cu_2$ . The submarginal band is broken or incomplete. On the HW, spots 5 and 6 are small with 6 frequently reduced to a black dot. The anal band or chevron in cell 2V is usually absent, or very faint if present. The basal and inner margin dark dusting on the HW is light. In both sexes, spot 2 is only  $1/3$  to  $1/2$  as wide at its base as the width between veins  $Cu_1$  and  $Cu_2$ . In the females, the chevron row is nearly obsolete with distinct chevrons in cells  $Cu_2$  and 2V only. On the FW, both the marginal and submarginal dark bands are quite narrow, and the postmedian band is broken in cell  $M_3$ . Figure 2 illustrates the FW maculation in the males. In the females, spot 1 is nearly obsolete.

*P. CLODIUS GALLATINUS* STICHEL, 1907

This butterfly was described from Gallatin Co., Montana. It ranges from NW Wyoming through western Montana to Glacier National Park (E. M. Perkins, Jr., *in litt.*). In both sexes, spot 2 is from  $1/2$  to  $2/3$  as wide at its base as the width between veins  $Cu_1$  and  $Cu_2$ . Spots 5 and 6 are well-developed and red, with a black satellite spot to 6 in cell  $M_3$  frequently appearing in the females. Spot 4 may be small in the males, but the postmedian band is lightly connected and complete. The females exhibit a distinct and complete postmedian band. In that sex, spot 1 is distinct. Figure 3 illustrates the FW maculation in the males. The chevron row in the females is faint but present, and the anal band in the males is faint-to-obsolete in most specimens.

*P. CLODIUS ALTAURUS* DYAR, 1903

This is the most distinct of the three subspecies under discussion. It was described from a short series taken by T. B. Evermann, July 26, 1896 at Alturas Lake, in the Sawtooth Mountains of central Idaho. Its range appears to be restricted to Blaine and Custer Counties and it is perhaps a glacial relict. It occurs at higher altitudes than the other *clodius* forms found in the state. See Hovanitz, 1968 for a discussion of present and ice age life zones and distributions. In 1902 (p. 1, entry 1b), Dyar first attributed *altaurus* to Wyoming, but he corrected this error in his 1903 description of the taxon. This error is probably responsible for subsequent Wyoming citations for this subspecies.

The primary character by which *altaurus* is separated from other races of *clodius* is the yellow color of spots 5 and 6. Other characters, as shown in Figure 1, are as follows: In both sexes, the base of spot 2 is as wide as the space between veins  $Cu_1$  and  $Cu_2$ . Spot 4 is large and the postmedian band is solidly connected in both sexes. The anal band or chevron row is quite distinct in the males, and especially so in the females. In the females, spot 6 may exhibit a satellite spot in  $M_3$ , and in some examples, there is a narrow dark connecting band from the bottom of spot 6 to the top of the anal band. Spot 1 is distinct.

Another subspecies of perhaps doubtful status enters our area in Nez Perce Co., Idaho. This is *shepardi* Eisner, 1966 for which the type locality is Wawawai, Snake River, Whitman Co., Washington. It is a large and red-spotted race with its closest affinity to the northwestern subspecies *hel* Eisner, 1956 [T. L.

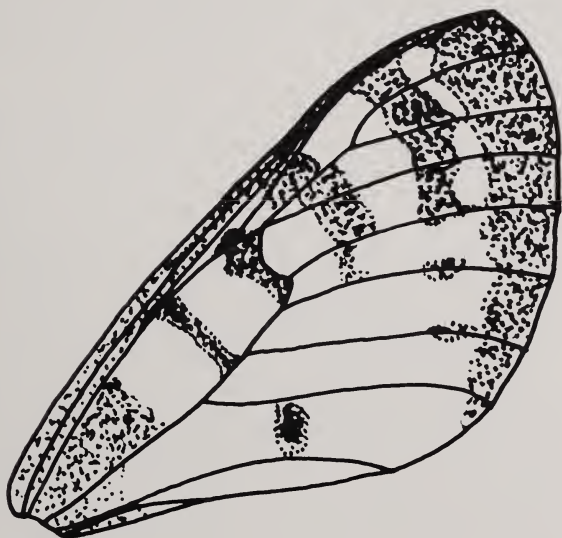


Fig. 2.—Forewing maculation of male *P. c. menetriesii*.

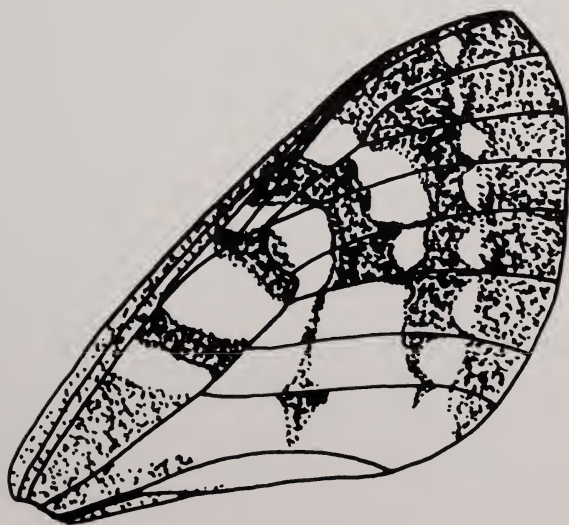


Fig. 3.—Forewing maculation of male *P. c. gallatinus*.



Stevens Pass, Washington] and *claudianus* Stichel, 1907 [T. L. "Washington"]. This author defers to Dr. Emmel to determine the status and validity of the northwestern *clodius* taxa.

Red-spotted *clodius* forms have been taken in Bannock, Bear Lake, Bonneville, Clearwater, Fremont, and Valley Cos., Idaho. All of the specimens examined were clearly intergrades between *menetriesii* and *gallatinus*. One male from nr. Fir Creek Campground, T12N, R10E, Valley Co. showed dark maculation approaching *altaurus*, but the spots were red. This is not surprising since Valley Co. borders on Custer Co. in which *altaurus* is found. Weak interaction between *altaurus* and the lower elevation red-spotted forms is to be expected in this region. Similar interaction is occasionally found in SE Idaho. Two yellow-spotted specimens, which in dark maculation are intergrades between *altaurus*, *gallatinus* and *menetriesii*, are in the W. N. Burdick collection at the University of Colorado Museum. These were taken on Pine Creek Pass, Bonneville Co. In the J. D. Eff collection, there is a phenotypic *gallatinus* taken on a low summit in SE Blaine Co., where *altaurus* flies at higher elevation.

In his 1935 monograph, Bryk included two other taxa in the Rocky Mountain fauna. One was *baldur*, previously mentioned, a California Sierran race. It was reputed to occur in the Teton Mountains based upon misidentification of a single strongly red-marked female *gallatinus* from Jackson Hole. *P. clodius sol* was described from a mixed series that included specimens from Nevada (probably the Sierra Nevada in California, Eisner, 1961) 3 males from Gunnison Co., Colorado, and a pair from the Teton Mtns. Although McDunnough, 1936, questioned the validity of *sol* because of the wide geographic area involved and overlapping ranges of other subspecies, Bryk and Eisner, 1937, adamantly defended their actions. The discussion in the Howe book restricts the range of *sol* to northern California. The Gunnison Co. record is either an error or the specimens were mislabeled, as these are the only Colorado records for *clodius*, in spite of extensive collecting in that state. All of the Teton Mountains records refer to *gallatinus*, or intergrades with *menetriesii*.

Figure 4 shows the distribution of *P. clodius* in the region treated by this paper. Because of the number of specimens involved, individual locality records are not cited to conserve space. Records by state and county are: *menetriesii*: UTAH:

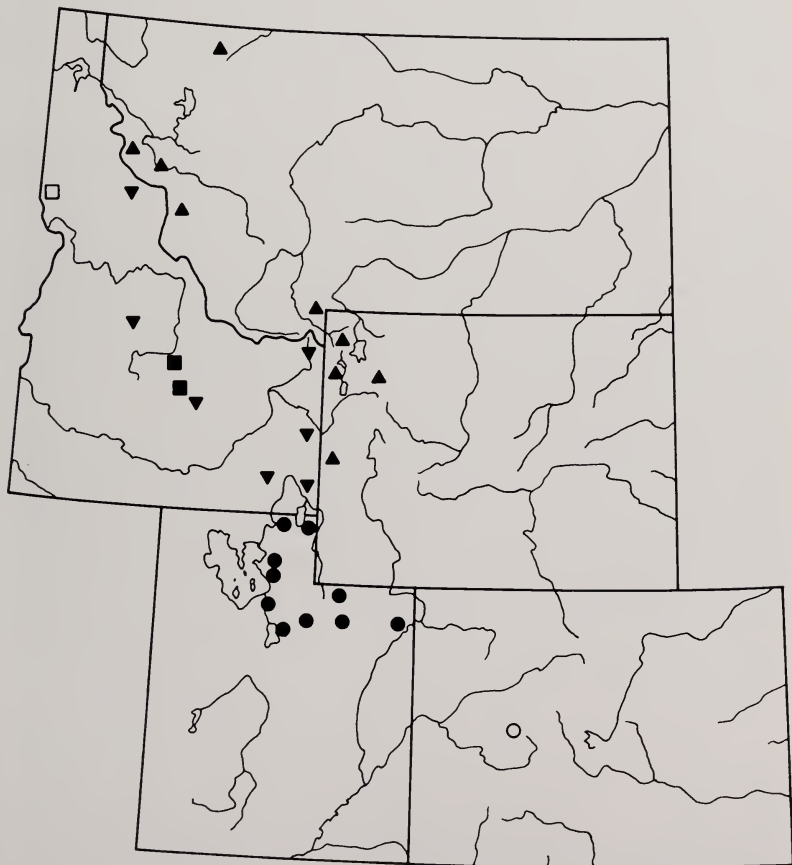


Fig. 4.—Distribution by county of *P. clodius* in the Rocky Mountains of the United States. Solid dot = *menetriesii*; triangle = *gallatinus*; solid square = *altaurus*; open square = *shepardii*; inverted triangle = *menetriesii-gallatinus* intergrades; open circle = questionable Gunnison Co., Colorado record.

Cache, Davis, Duchesne, Rich, Salt Lake, Summit, Uintah, Utah, Wasatch, Weber. *gallatinus*: **WYOMING**: Fremont, Lincoln, Teton, Park (Yellowstone N. P.); **MONTANA**: Gallatin, Glacier, Mineral, Missoula, Ravalli. *altaurus*: **IDAHO**: Blaine, Custer. *shepardi*: **IDAHO**: Nez Perce. Intergrade forms *menetriesii-gallatinus*: **IDAHO**: Bannock, Bear Lake, Bonneville, Clearwater, Fremont, Valley. The Utah records are from Callaghan and Tidwell, 1971.

A female cotype (syntype) of *menetriesii* is in the Henry Edwards collection at the American Museum of Natural History in New York City. This specimen, collected by I. D. Putnam at Mt. Nebo, Utah, figured by Skinner, 1916 (pl. XII, fig. 3) and mentioned by Barnes and McDunnough (1918), is hereby designated the lectotype for the taxon *menetriesii*. A red label, hand-printed in black ink, which reads: "*P. clodius/menetriesii* H. Edw./LECTOTYPE/designated by C. D./Ferris, April, 1976" has been affixed to the specimen pin.

Stichel's description of *gallatinus* was based upon a pair figured by Elrod, 1906 (page 16, fig. 15). The type specimens are currently in the entomological collection of the University of Montana at Missoula; it has been recommended that they be deposited in the collection of the American Museum of Natural History. They were collected by Prof. R. A. Cooley on 27 June, 1900 at 6800' (2027 m) in Gallatin Co., Montana. An additional pair (not designated as paratypes) is in the Cooley collection at Montana State University, Bozeman.

The type of *altaurus* is type specimen no. 6769 in the United States National Museum collection. It was collected by T. B. Evermann on 26 July, 1896 at Alturas Lake, Blaine Co., Idaho, 7000' (2134 m). Dyar did not figure *altaurus* in either his 1902 or 1903 papers. Howe has illustrated two subspecies under the name *altaurus*. Plate 68, figs. 13-14 depict *gallatinus* while figs. 15-16 are *altaurus*.

The types of *shepardi* are in the collection of the Rijksmuseum of Natural History, Leiden, Netherlands. Eisner figured the types (1966, pl. 1, f. 1-2); a topotypical male is figured by Howe (pl. 69, fig. 16).

## SUMMARY

During the course of this study, three factors became apparent which have influenced the taxonomy of *Parnassius* in North America and have contributed to the confusion surrounding this genus. Many of the taxa have been described by European workers and it is evident from reading their papers that they had no understanding of North American geography. This has led to some of the problems. A major problem has been the erection of new taxa based upon very few specimens; in some cases only one or two. With a genus as variable as *Parnassius*, it is essential that long series be studied. Lack of familiarity with existing literature has contributed its share of problems, as confessed by Bryk and Eisner in their 1937 reply to McDunnough's 1936 criticism. It is essential that anyone doing taxonomic work search out the appropriate existing literature.

Many of the papers in which new *Parnassius* taxa are proposed lack any discussion of the variability in facies within the subspecies described, let alone adequate discussion of characters by which the proposed subspecies can be separated from its allies. Some taxa have been described from museum specimens collected many years prior to study. This can lead to difficulties as a result of specimen fading. With time, and elevated temperature in some cases, the red spots tend to assume an orange, pink or even yellow-orange cast not found in fresh material. In some forms, considerable fading occurs while the specimen is still alive, if it has been on the wing for several weeks. These situations have perhaps caused some workers to lump *gallatinus* and *altaurus*, when in fact, they are quite distinct entities.

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## LEPIDOPTERAN FOODPLANT RECORDS FROM TEXAS

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OVER THE PAST SEVERAL YEARS, a number of foodplant records of Texas lepidoptera have been recorded. Observations have been concentrated in Brownsville, Cameron Co., and Austin, Travis County, Texas. Foodplant information for a particular species is needed from various localities at different times of the year if spatial and temporal variations in foodplant utilization are to be determined and understood (see e.g. Neck, 1973; Singer, 1971). This annotated list is provided for those who may work on any of the following species in the future. Plant nomenclature follows that of Correll and Johnston (1971) or Bailey (1949).

### NYMPHALIDAE

*Chlosyne nycteis* (Doubleday). Larvae of the silver checker-spot have been found on only one plant in central Texas—frostweed, *Verbesina virginica* L. (Compositae). In laboratory cages, adults which were given a choice between common sunflower, *Helianthus annuus* L., and cowpen daisy, *Verbesina encelioides* (Cav.) Gray, chose the latter. *H. annuus* has been reported as a *nycteis* foodplant in Kansas (Walker, 1936); in central Texas *nycteis* has never been found on sunflower which is a major foodplant of *Chlosyne lacinia* var. *adjutrix* (Neck, 1973).

*Cynthia cardui* (L.). The painted lady is known to feed on innumerable plants of many families; most important are Malvaceae, Compositae and Leguminosae (Williams, 1970). Field (1971:44) states that "foodplants of the larvae are principally members of the Compositae and most especially the various thistles." In central Texas larvae are commonly found on Texas thistle, *Cirsium texanum* Buckl. (Compositae), but larvae were also discovered on silver-leaf sunflower, *Helianthus argophyllous* T. & G. (Compositae) on 27 April 1970. This sunflower record

was observed in the transplant garden of the Brackenridge Field Laboratory of the University of Texas at Austin. *H. argophyllous* does not occur naturally at this site; however, larval nests identical to those of *cardui* have been seen on this plant in native habitat, 16 km south of Luling, Caldwell Co. No *Helianthus* has previously been recorded as a larval foodplant for *cardui* (Field, 1974:44). Adults have been seen flying around the related cultivated plant, artichoke, *Cynara scolymus* L. (16 May 1973). No eggs or larvae were found on this plant. Possibly significant is the visual similarity of these three plants—all have a gray-green appearance.

*Phyciodes tharos* (Drury). The pearl crescent utilizes Texas aster, *Aster texanus* Burgess (Compositae), in central Texas. Eggs are preferentially laid on the basal leaves as opposed to the leaves of flowering stalks which appear in the fall. This species has previously been reported to utilize *Aster prealtus* Poirlet in Gonzales Co. (ca. 100 km SE of Austin) (see Kendall, 1964). Larvae of *Chlosyne harrisii* (Scudder), refused to eat leaves of this plant (3rd instar larvae supplied by V. G. Dethier). *C. harrisii* is native to the northeastern United States where it feeds on *Doellingeria umbellata* (Mill.) Nees (see Dethier, 1959), a plant placed in *Aster* by some authorities (Correll and Johnston, 1970).

*Precis lavinia coenia* (Hubner). This buckeye has been reared from common ruellia, *Ruellia nudiflora* (Gray) Urban (Acanthaceae) in Austin, Travis Co.

## HELICONIIDAE

*Agraulis vanillae* L. The Gulf fritillary feeds on many species of passionvines (Passifloraceae). In Travis County, it has been found feeding on the three native species—*P. lutea* L., *P. tenuiloba* Engelm. (see Parks, 1935, for previous report on *P. tenuiloba* elsewhere) and *P. affinis* Engelm.—in addition to two introduced species—*P. caerulea* L. (native to Brazil—Bailey, 1949) and *P. foetida* L. var. *gossypifolia* (Hamilt.) Mast. (native to south Texas—Correll and Johnston, 1970). These latter two plants support greater larval populations (at least on a per plant basis) than the former three, probably because these two exhibit much greater biomass levels. A larva feeding on *tenuiloba*, particularly, is likely to strip an individual plant, necessitating a ground search for additional foodplant material much as larvae of *Battus philenor* (L.) search for additional *Ariso-*

*lochialia longiflora* Engelm. and Gray (see Kendall, 1964). *A. vanillae* faces periodic competition from *Heliconius charitonius vasquezae* (Comstock and Brown) and *Dryas julia moderata* (Stichel) in certain years, e.g. 1968, when these species establish breeding populations in central Texas. The Gulf fritillary may have been considerably less common before the introduction of these two non-native Passiflora. Much *P. foetida* was killed back by the severe weather of the 1972-73 winter; recovery of plants has occurred since that time. *P. caerulea* is relatively unaffected by cold weather, retaining green foliage throughout the winter.

### DANAIDAE

*Danaus plexippus plexippus* L. In the area of Brownsville, Cameron Co., larvae of the monarch are commonly found on the introduced bloodflower, *Asclepias curassivica* L., which is native to tropical America. Larvae of the monarch are rarely found in the Travis Co. area. However, on 4 October 1971, two monarch larvae were found on milkweed vine, *Matelea reticulata* (Gray) Woods (also Asclepiadaceae).

*Danaus gillippus strigosus* (Bates). The queen in the Brownsville area also utilizes *A. curassivica*. In fact, when the monarch is present in this area (normally only spring and fall but see Neck, 1976), larvae of both species may be found on the same plant. Larval foodplants of the queen in the Travis Co. area are unknown to this writer.

### LIBYTHEIDAE

*Libytheana bachmanii larvata* Strecker. The snout butterfly is a well-known feeder on various *Celtis* (Ulmaceae) throughout North America. Kendall and Glick (1972) reported granjeno or spiny hackberry, *C. pallida* Torr., is the preferred foodplant in south Texas. This *Celtis* is uncommon in central Texas. Personal observations of larvae of *larvata* have included Texas sugarberry, *C. laevigata* Willd., and hybrid *C. laevigata* X *reticulata* at Austin, Travis, Co. Although no larvae have been found on "pure" net-leaf hackberry, *C. reticulata* Torr., this plant is assumed to be acceptable as a larval foodplant for *larvata*. Breeding in central Texas is at a very low level, except during periodic epidemic-like migrations; even in such situations, larvae are not common.

## SPHINGIDAE

*Erinnyis ello* (L.). Larvae of the ello sphinx are quite common on poinsettia, *Euphorbia pulcherrima* Willd. (Euphorbiaceae) in Brownsville. Previous records of this plant as a larval foodplant are known from California (Comstock and Dammers, 1938), Florida (Kimball, 1965:63) and Jamaica (Curio, 1970). Poinsettia could well be a native foodplant in tropical Mexico and Central America. Foodplant records for this species are concentrated in the Euphorbiaceae but also include papaya (Caricaceae: *Carica papaya* L.) in Florida (Kimball, 1965). The only known record of a native larval foodplant for *E. ello* in Texas is *Bumelia angustifolia* Nutt. (Sapotaceae) by Rickard (1975).

*Erinnyis obscura* (Fabricius). This species is much less common than the above species, but larvae of both species have been found on the same poinsettia plant at the same time (especially summer 1961). Foodplant records from Florida and Jamaica (Kimball, 1965; Dyar, 1901) include several members of the Asclepiadaceae and papaya (Caricaceae). These three families known to include larval foodplants of *E. obscura* are unrelated, belonging to different orders (Lawrence, 1951). However, all species involved have a milky sap. The evolution of milky sap in these families was independently derived, but some common or similar chemical characteristic(s) of these saps may be an attractive substance for adult females of *E. obscura* which are searching for oviposition sites.

*Hyles lineata* (Fabricius). In Travis Co. larvae of the striped sphinx are known to feed on scarlet spiderling, *Boerhavia coccinea* Mill. and common four o'clock, *Mirabilis jalapa* L. Both plants are members of the Nyctaginaceae. The former is native to central Texas; the latter is naturalized in central Texas (native to tropical America).

*Manduca* spp. Both *M. sexta* (Linnaeus) and *M. quinquemaculata* (Haworth) are found commonly on tomato, *Solanum lycopersicon* L., and occasionally on potato, *Solanum tuberosum* L., in Travis Co. *M. sexta* has been found on silverleaf nightshade, *Solanum eleagnifolium* Cav. in Travis Co. at a number of times (May-November). *M. quinquemaculata* has been found on *eleagnifolium* in Jeff Davis Co. on State Highway 17 between Balmorrhea and Ft. Davis (Oct. 1974).



## SATURNIIDAE

*Automeris io* (Fabricius). The io moth in central Texas most commonly feeds on Texas sugarberry, *Celtis laevigata* Willd. (Ulmaceae). Several times mature larvae of this species have been found feeding on Indian corn, *Zea mays* L. (Gramineae). Larvae are believed to have shifted from *Celtis* trees in the near vicinity. However, as this apparent shift has been observed several times, such foodplant crossover is significant enough to be reported. In Austin, I have collected larvae on turk's cap, *Malvaviscus arboreus* Cav. var. *drummondii* (T. & G.) Schery (Malvaceae). Larvae of *A. io* have been collected on tepeguaje or giant leadtree, *Leucaena pulverulenta* (Schlect.) Benth. (Leguminosae) in Brownsville, Cameron Co.

## ARCTIIDAE

*Hyphantria cunea* Drury. Larvae of the fall webworm have been reported to feed on an incredibly long and diverse list of plants—"nearly all deciduous shrubs and trees" (Snodgrass, 1922). In Austin, this species is most commonly found on pecan, *Carya illinoensis* (Wang.) K. Koch (Juglandaceae), in both residential and natural areas. Other recorded foodplants in residential areas include the following: Arizona ash, *Fraxinus velutina* Torr. (Oleaceae); sycamore, *Platanus occidentalis* L. (Platanaceae); red mulberry, *Morus rubra* L. (Moraceae); Texas sugarberry, *Celtis laevigata* Willd. (Ulmaceae); and peach, *Prunus persica* (L.) (Rosaceae). Trees attacked in natural areas have included rough-leaf dogweed, *Cornus drummondii* C. A. Mey (Cornaceae), and possumhaw, or deciduous yaupon, *Ilex decidua* Walt. (Aquifoliaceae). All of the above records represent oviposition by adult females as these plants supported the webs characteristic of the younger larvae of this species. Larvae of the final instar disperse from the feeding web and feed more or less individually. Final instar larvae have been observed feeding on spinach, *Spinacia oleracea* L. (Chenopodiaceae).

## NOCTUIDAE

*Basilodes catharops* Dyar. The yellowish (with black markings) larvae of this species become very common on cow-pen daisy, *Verbesina encelioides* (Cav.) Gray (Compositae), each fall in Travis Co.



*Heliothis virescens* (F.) The tobacco budworm, a major agricultural pest, is known to feed on a number of agricultural crops as well as many native members of the Texas flora (Graham, et al., 1972). Larvae have been found on velvetleaf, *Wissadula holosericea* (Scheele) (Malvaceae) in Austin, Travis Co. This plant has previously been reported as a foodplant in Tamaulipas, Mexico (Lukefahr in Graham and Robertson, 1970), but it has not previously been reported for Texas populations of *virescens*.

*Schinia* spp. Species of this genus are intimately associated with their foodplant. Not only does the plant serve as a larval food source (larvae burrow into the immature fruit), but also a resting spot for the adult which is color-matched to the inflorescence (see Hardwick, 1958). *Schinia voluupia* (Fitch) is found associated with *Gaillardia pulchella* Foug. (Compositae). *Schinia siren* Stkr. has been found associated with *Verbesina encelioides* (Cav.) Gray (Compositae). Adults of both species have been reared *ex larva* from the respective foodplant.

### MEGALOPYGIDAE

*Megalopyge opercularis* Sm. & Abb. The puss caterpillar or Mexican asp has been found most commonly in Austin on Texas sugarberry, *Celtis laevigata* Willd. (Ulmaceae), but larvae have also been found on cedar elm, *Ulmus crassifolia* Nutt. (Ulmaceae); garden geranium, *Pelargonium hortorum* Bailey (Geraniaceae); and common rose, *Rosa* sp. (Rosaceae). In Brownsville, the most common native foodplant is also *C. laevigata*, but other native species are utilized, e.g. Mexican ash, *Fraxinus berlandieriana* A. DC. (Oleaceae). The most widely utilized ornamental is Natal plum, *Carissa grandiflora* A. DC. (Apocynaceae—native to south Africa), but larvae also infest other ornamental species, e.g. Chinese tallow, *Sapium sebiferum* Roxb. (Euphorbiaceae—native to China and Japan); Japanese honeysuckle, *Lonicera japonica* Thumb. (Caprifoliaceae—native to east Asia); and esperanza, *Tecoma stans* (L.) Juss. (Bignoniaceae—native to Trans-Pecos Texas).

### PYRALIDAE

*Sylepta obscuralis* (Led.). Larvae of this species have been found (July 1969) on lotus, *Nelumbo nucifera* Gaertn. (Nymphaeaceae). Immature larvae feed on the blade of the leaf but mature larvae feed inside the central leaf petiole.

## TORTRICIDAE

*Archips rileyanus* (Grote). The gregarious larvae of this species spin a web which encloses the terminal leaves of Texas buckeye, *Aesculus pavia* L. (Hippocastanaceae). Larvae have been seen at Pedernales Falls State Park, Blanco Co. (12 March 1972) and Landa Park, New Braunfels, Comal Co. (March 1976).

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## MIGRATION OF *HIPPARCHIA SEMELE* L.

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### ABSTRACT

A migration has been recorded for the first time of the Grayling, (*Hipparchia semele* Linnaeus 1758) (Lepidoptera: Satyridae) in southern France. The migration occurred in the Cevennes mountains (north of Montpellier and west of Nîmes) in the commune of St. Martial (30440) from 3-7 September 1975. Details of the migration are given.

### METHOD

All results were taken from a 25m transect which was bounded on one side by an electricity pylon and on the other by a house. All butterflies passing between these two points were noted for five minute periods during four hours of observation. The observer was seated in a chair between the two points and was able to see oncoming insects. One hour of observations was made on the 4 September from 1045-1145 hrs, two hours on the 5 September from 1010-1110 hrs and 1300-1400 hrs and one hour on the 7 September from 1300-1400 hrs.

### RESULTS

**Start** The migration was first noticed on the 3 September when 48 *H. semele* were seen to come over the terrace of a house during a ten minute period from 1300 hrs. In retrospect there were plenty of *H. semele* around on the days previously but no attention was given to them.

**Direction** The insects were flying in a SE direction which was always constant. From the observation point it was possible to see the insects come down a steep slope then join a small track and continue up this until face to face with the observer. The insects continued past the observer and then descended another steep slope until out of sight. At the bottom of the slope the

insects would have come across a very steep mountainside, but it was not possible to determine whether they surmounted this obstacle (about 300m) or were deflected to the right and thus out of the valley to the south.

*The Front* It was not possible to determine exactly the true extent of the front. However, from where the observations were made the passage of insects was in progress 1000m to the south and 50m to the east. Observations made from a motor vehicle between two villages 14k to the south and out of the mountain range, on 3 September between 1030-1100 hrs showed that *H. semele* was on the move southeastwards in enormous numbers. The insects were continually crossing the road in one direction between St. Hippolyte du Fort and Sauve, a distance of 7k. Again on the 5 September along the same road but between St. Hippolyte du Fort and Ganges (13k) the author witnessed *H. semele* continually moving across the road in vast numbers and going in the same direction. On the 8 September when the author was driving away from the region he noted that plenty of *H. semele* were still moving off the cols in a south easterly direction up to 50k to the north.

*Numbers* As Table 1 indicates there were large numbers of *H. semele* passing the 25m transect every five minutes. The maximum which passed in a five minute period was 28, and only on one occasion were there none recorded. The average number passing every five minutes for the four hour periods was 13. The total numbers of *H. semele* passing for the four hours were 228, 142, 189 and 37. No *H. semele* were seen to pass in the opposite direction at any time.

From 3-7 September the migration was seen to be in progress for 13½ hours as follows:

Total period of migration 3-7 Sept.		
Date	Time	Number of hours of migration
3 September	1000-1315	3.15
4 September	1045-1600	5.15
5 September	1000-1400	4.00
7 September	1300-1400	1.00
Total		13.30



*Flight Habits* One of the outstanding features of the migration was that the *H. semele* would frequently come past in groups of two or three, and seemed to be 'chasing' each other. Occasionally groups of up to five would fly past. There would always be one or two groups of these insects passing during most five minute periods. The speed of the migrating insects was estimated to be about 10-11kph. Typically the flight direction was always constant and seemed 'purposeful'. The insects were never seen to pause to visit flowers and did not exhibit their characteristic habits familiar with the higher ground where they are plentiful, (i.e., they did not dart off on short flights and alight in some inconspicuous place). Insects travelling up the track would keep close to the ground at about 10cm above, except when they would rise over an obstacle such as a house which stood in their flight path. On many occasions *H. semele* was seen to rise over a massive spiralling swarm of 'midges' at the top of a lime tree (*Tilia* sp.) after having come over the rooftops of a house. Only very occasionally specimens of *H. semele* were seen to be flying at about 10-15m above the ground.

*Other Species* Drawn along with the migrating stream of *H. semele* there were seven other species of Lepidoptera of which the most common were the Common Blue (*Polyommatus icarus* Rott.) (117 spp.), and the Small White (*Pieris rapae* L.) (110 spp.). The other species involved were the Large White (*Pieris brassicae* L.), the Great Banded Grayling (*Brintesia circe* Fab.), the Wood White (*Leptidea sinapis* L.), the Small Copper (*Lycaena phlaeus* L.) and a Swallowtail (*Papilio machaon* L.). Two other insect orders were involved. Four dragonflies (Odonata, sp. unidentified) flew past in the same direction and many syrphids (Diptera) flew past at a very fast rate, probably about 16-24kph.

## DISCUSSION

The Genus *Hipparchia* has come under revision and has been scrutinised critically by Kudrna (1975), who has recently described a new species in Europe. It is hoped that the details presented in this present paper will serve to increase the knowledge on the migratory habits of *H. semele*.

*Abundance of H. semele* *H. semele* has been recorded as being common in the Parc des Cevennes, (which includes the commune of St. Martial) (Feltwell, in press), and is found throughout the Cevennes including Mt. Aigoual (1565m), on the Causse Noir to

the west and at Concoules where it occurs between 700-800m (Gaillard 1959).

It has been the frequent experience of the author that when visiting the many cols of the region (of up to 1500m) there are always many hundreds of *H. semele* flitting about which are disturbed with every step. They are always in company with thousands of blue and red winged locusts (*Oedipoda* spp.). Foodplants of *H. semele* are grasses, particularly *Deschampsia* and *Agropyron* (Higgins and Riley, 1973), of which there are plenty on the sheep grazed slopes.

A typical habitat in which the Grayling can be found has been eloquently described by Rowland-Brown (1909), though for a region just to the north of the Cevennes 'the stony approaches to the Causse (Lot) were hung with scented clematis, with a dense underwood of wild gooseberries, exuberant of thorns, but jewelled with tiny luscious gold and crimson fruits . . . *Satyrus alcyone* perhaps the most in evidence, but *Hipparchia semele* and *circe* running it close in point of numbers'.

*Evidence for migration.* Migration of *H. semele* has hitherto been unrecorded (Williams 1930, 1958), and indeed all other species of the same taxa are known to be non-migratory. However, 10 specimens collected (while sitting on the chair) from the migratory stream were positively identified by Kudrna as true *semele* on the basis of their genitalia and were definitely of the southern French form.

The data presented in this paper together with evidence from Baker's (1969) theory on the evolution of the migratory habit in butterflies, and observations made by the author and Kudrna in the past lend support to the view that *H. semele* does in fact migrate.

Baker (*loc. cit.*) in his assessment of the degrees of movement exhibited by the 68 species of British butterflies predicted that *H. semele* would be expected to show infrequent voluntary displacement (Group III of his classification). His prediction was based on analysis of three factors, a) the nearness of the larval foodplant sites, b) the diffuseness of adult and larval habitats and c) the frequency with which new foodplant sites arise.

Observations reported previously by Feltwell (1975) in the same region of France that 'at the end of August 1967 "hundreds" of "browns" were reported (by another) moving east over a mile stretch of road above the village of St. Martial', may have also been migratory movements of *H. semele*.

Furthermore Kudrna (1974 and *pers. comm.*) observed in the Sierra de Alfacar (1500m) in southern Spain (Province of Granada) during 3-5 July 1973 *H. semele subcinerea* Ribbe flying 'down the hill' all going in one direction and following a mountain track bordered by a thin pine wood. The number of butterflies in this migration was not large and at the time Kudrna was not of the opinion that it was a migration. This latter point would tend to support what was observed in the Cevennes. Only after quantitative data is accumulated does the significance of a thin trickle of insects become more apparent. The division between movements and migrations has not been clearly defined and possibly other reports or observations, whether published or unpublished, of *H. semele* will come to light to clarify this position.

The intensity of the migration when measured on the seven point scale of Williams (1958 p. 103) would appear to fall between Division III and IV, i.e., III "Thin, should be obvious to any competent field naturalist" and IV "Definite, obvious to any normal person". Williams (*loc. cit.*) quoted as an example of III a migration of Large White Butterflies which passed through Harpenden during July-August 1940 when the insects were crossing a 100 yard front at a maximum of 12 per minute. The average number of *H. semele* passing over a front measured as 100 yards in this case compared closely with Williams' example, at 11 per minute. However, the maximum recorded over the 25m transect in any five minute period was 28 which would be equivalent to 31 per minute over a 100 yard front.

Thus one of the important features of the migration was that it was diffuse. To the casual onlooker it had to be pointed out in order to be seen and then it was fairly obvious. Such a diffuse migration could lead to a dispersal of 'thousands' of insects if the migratory stream was kept up for a long time and if the front was wide. Unlike other migratory lepidoptera where clouds of insects are involved, the migratory stream was always a regular trickle coming from the same direction. It is perhaps worth mentioning that a migration of *P. brassicae*, involving probably a million butterflies during a two day period in Finland in 1963 was progressing at its best at a rate of 10-20 individuals past a 50m transect every 10 minutes (Vepsäläinen 1963), thus representing a much more diffuse migration than recorded here for *H. semele*.

Lateness of the season may be a factor which is favourable for the migration in the Grayling. Gaillard (1959) mentioned

that *H. semele* is out from 30 June to 25 August and Higgins and Riley (1973) quote July and August. The summer of 1975 was particularly hot and dry, especially the first week of August when the continent suffered a heatwave. A similar late migration of *P. brassicae* was observed in SW France in 1963, and here the insects were flying southwards from 16-30 September (Angelade *et al*, 1963).

*Quantitative considerations.* Although the migration was in progress for 13½ hours throughout most of the warmest parts of the days concerned only four hours of almost continuous observations were carried out. There did not appear to be more insects flying at noon and from inspection of the results, where temperatures were taken, there did not appear to be more insects moving when the temperatures were at their highest.

From the observations already quoted in this communication it is clear that *H. semele* was moving at different times and different places over a front of at least 64k, i.e., between the two most distant points of observation. However, there was no way to determine whether the migration was continuous throughout the entire length of this front.

It would be foolish to make any kind of quantitative assessment of how many insects were involved in this migration beyond the limits of the experimental work; one of the practical limitations being the inability of the observer to be in all places at the same time. However, it is sufficient to note that the migration was in evidence at St. Martial for a total of 13½ hours and that during four of these hours 596 *H. semele* were recorded past a 25m transect. The immediate width of the front was about 1500m and there is some evidence that the front could have been as wide as 64k. The overall impression therefore was of a migration of *H. semele* moving down from their breeding sites on the cols and dispersing southeastwards towards the Garrigue of Nîmes and Montpellier.

*Other species.* The influence of migrating *H. semele* on other species of butterfly appeared to be quite considerable. During the four hours of observation 264 specimens of seven other species were drawn along, representing 44% of the total number of *H. semele* migrating. Approximately equal numbers of *P. icarus* and *P. rapae* passed during this period. The population of *P. icarus* is extremely large in this area and it was not surprising to find plenty of this species involved in the migration.

An interesting point about the direction of flight of all these insects was that it was definite; a characteristic also noted for



*P. brassicae* by Angelade *et al* 1963. They also found that migrating Large Whites did not pause to visit flowers, similar indeed to observations in this migration. Of the 860 specimens of all species recorded past the 25m transect only one specimen, that of a Painted Lady (*Vanessa cardui* L.) was recorded going in the opposite direction; and it was curious that this was the only specimen of a species which is documented with a marked migratory habit.

It is to be hoped that the data expressed in this paper will stimulate others to take a closer look at movements of insects, particularly diffuse ones, so that a better understanding between movements and migrations can be appreciated.

### ACKNOWLEDGEMENTS

I would like to express my thanks to M. Patrick Ducros for kindly assisting me in the collection of data during the four days of the migration. My thanks are also due to Otaka Kudrna (Portsmouth Polytechnic) for very kindly determining the *H. semele* by their genitalia, and to Dr. Robin Baker (Manchester University) for giving me his opinions on migratory theory. To both of them I would like to extend my thanks for commenting on the manuscript.

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TABLE 1

Movement of *H. semele* and other species across  
a 25m transect

Date and Time	Temperature °F	<i>H. semele</i>	<i>P. icarus</i>	<i>P. rapae</i>	Other spp.
4 Sept.					
1045	76	8	0	2	0
1050		16	1	1	1
1055		20	2	3	3
1100		13	5	1	2
1105		28	1	1	1
1110		17	3	1	1
1115		22	1	1	2
1120		17	1	0	1
1125	78	26	1	0	0
1130		27	1	3	0
1135		15	4	2	1
1140		19	3	3	0
Total		228	23	18	12
5 Sept.					
0945	74	0	0	0	0
1010	75	9	0	3	0
1015		7	0	2	0
1020		9	2	4	0
1025		10	3	3	1
1030		11	3	2	0
1035	77	8	2	2	0
1040		13	5	2	0
1045		10	2	1	0
1050		12	3	1	0
1055		13	2	3	1
1100	74	19	3	0	1
1105		21	1	1	1
Total		142	26	24	4

TABLE 1 (continued)

1300*	20	5	4	0
1305	11	7	3	0
1310	16	4	3	2
1315	20	10	3	0
1320	16	4	3	2
1325	22	7	3	2
1330	23	2	3	4
1335	20	5	5	3
1340	24	4	3	0
1345	8	4	3	1

1350	2	2	2	3
1355	7	4	5	2
Total	189	58	40	19
7 Sept.				
1300*	5	1	4	2
1305	9	3	3	2
1310	8	1	2	0
1315	4	1	3	2
1320	5	2	2	2
1325	2	0	2	0
1330	0	0	0	0
1335	2	1	3	0
1340		Not recorded		
1345		Not recorded		
1350		Not recorded		
1355	2	1	3	0
Total	37	10	22	8
Overall				
Total	596	117	104	43

\* Temperature not recorded for this hour.

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## AMBLYSCHIRTES "ERNA,"

A FORM OF AMBLYSCHIRTES AENUS

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AMBLYSCHIRTES "ERNA" Freeman is distinguished from *A. aenus* Edwards by having smaller wing spots. On May 20-21, 1973, I collected 85 *Amblyschirtes* of these two entities at Black Mesa, Cimarron County, Oklahoma (from where *erna* but not *aenus* was recorded by Freeman, 1973), and adjacent Furnish Canyon, Baca County, Colorado. Most were of the heavily spotted form, but 16 had the ventral wing spots reduced to varying degrees and three were nearly immaculate. Prominence of the male stigma was somewhat variable as in most *aenus* populations. The darkest individual was a female from Furnish Canyon, which matched a female from the type locality of *erna* (Palo Duro Canyon, Armstrong County, Texas), and was even less spotted than the male holotype *erna* that I examined in the American Museum. The Furnish Canyon female laid several eggs which produced three male offspring, all of which were the normal *aenus* form with many whitish spots and a strong ventral fore wing reddish flush in the cell. Because 1) *erna* phenotypes are found with *aenus* phenotypes, and 2) *erna* phenotypes produce *aenus* offspring, I conclude that the two names represent endpoints of a continuum of variation of one species, *A. aenus*. *A. "erna"* seems to be a form, either genetic or environmental, of *A. aenus*. In my opinion *A. "linda"* Freeman is also a subspecies of *A. aenus*.

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## NORTH DAKOTA BUTTERFLY CALENDAR<sup>1</sup>

(INCLUDING POSSIBLE STRAYS)

TIM L. McCABE<sup>2</sup> & RICHARD L. POST<sup>3</sup>

THE STATE OF NORTH DAKOTA has an interesting intermingling of eastern and western elements. Variation in altitude in North Dakota is slight and gradual, ranging from 753 feet on the Red River at Pembina in the northeast to 3,468 feet on Black Butte in the southwest. To the north, the Turtle Mountains (elevation 2,500') rise 400-600 feet above the surrounding plain. They are of interest because of their aspen and oak forests which, together with the Pembina Hills, harbor many woodland and Canadian Zone species.

The prairies west of the Missouri River are too steep and rough to be cultivated. These "Badlands" remain in a primitive condition. The Badlands have not been glaciated in recent times as has most of the state. Glacial lakes Souris (now the Mouse River in the north), Sargent (Sargent County in the southeast), and Agassiz (Red River Valley), which were drained when the ice sheet receded, leave an interesting fauna wherever the sandy shorelines remain undisturbed. Irregularities between the successive beaches of the receded glacial lakes form numerous sloughs and marshes. The remainder of the state is prairie, marking the northern extension of the Great Plains.

136 species of *Rhopalocera* have been recorded in the confines of the state and an additional 10 species of likely occurrence (indicated by quotation marks) are included in the Calendar. Flight data for these 10 have come from the nearest available population. Numerous additions and deletions have been made since Puckering & Post's 1960 list of butterflies of North Dakota. A list of the skippers is presented here for the first time. The following butterfly species have been recorded

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from the state since 1960: *Colias alexandra* Edward, *Phoebus sennae eubule* (L.), *Papilio cresphontes* Cramer, *Danaus gilippus berenice* (Cramer), *Satyrium calanus* (Godart), *Plebejus shasta minnehaha* (Scudder), *Feniseca tarquinius* Fab., *Hemiargus isola* (Reak.), *Everes amyntula* (Boisduval), *Callophrys sheridanii* (Edw.), *Incisalia polia obscuris* Ferris, *Apodemia mormo mormo* (Felder & Felder), *Limenitis arthemis astyanax* (Fab.), *Polygonia satyrus* (Edw.), *Polygonia faunus rustica* (Edw.), *Chlosyne harrisii hanhami* (Fletcher), *Oeneis alberta alberta* Elwes, *Erebia discoidalis* (Kirby). The following have been deleted from the 1960 list because of misidentifications: *Papilio bairdii bairdii* Edw. (mistaken for *P. polyxenes asterius* Stoll) and *Polygonia gracilis* (G. & R.) (mistaken for *P. progne* (Cramer). Also, the following have been deleted because of incorrect data: *Euchloe ausonides ausonides* Lucas (specimen actually from South Dakota), *Oeneis chryxus calias* (Scudder), *O. c. strigulosa* McD., and *Erebia epipsodea sineocellata* Skinner. The last three are Satyrids (student collected - labeled Fargo) that do not exhibit marked migratory tendencies. The *O. chryxus* occurs to the northeast in northern Manitoba in the Precambrian region and is not considered an 'accidental' species in North Dakota. The *Erebia* is an unlikely 'possible' for northernmost North Dakota, but certainly not for the southeast.

The status of several species in the state remains unresolved. *Colias alexandra* has a previously unknown double brood in southwestern North Dakota. It is found in higher areas where its foodplant *Thermopsis rhombifolia* grows. *Papilio zelicaon-gothica* from the Badlands is still in a confused state. Mr. James Oberfoell's (Bowman, N.D.) rearing studies (unpublished) reveal a dark form which resembles *P. kahli* Chermock & Chermock of the Riding Mountains. Dr. R. L. Post has seen a specimen of *Danaus gilippus berenice* and three *Papilio cresphontes* from Fargo. Unfortunately, the specimens were lost when the Fargo Central High School burned down.

The format of the Calendar is as follows: Each month is divided into thirds. The various markings are an indication of flight periods. The markings indicate:

- (.) non flight period
- (-) few or worn specimens
- (\*) fresh specimens
- (") possible occurrence

Statewide occurring species appear two to three days earlier in western North Dakota. Species normally observed in May fre-



quently are observed earlier when above normal climatic conditions prevail in March and April; summer species are minimally affected. In the comments, "Badlands" refers to both the North and South Units unless otherwise specified. The 100th meridian divides the state into Eastern and Western halves. The arrangement and nomenclature follows Dos Passos (1964) and has been updated to follow most recent usage.

Following are some of the best collecting areas in North Dakota:

Area	Township - Range - Section
Alexander (3.5 miles N)*	T151N R101W S18
Amidon	T134N R101W S1 & 2
Burning Coal Vein overlook	T136N R102W S13 NW $\frac{1}{4}$
Burning Coal Vein ravine	T136N R102W S13 NW $\frac{1}{4}$ & 14 NE $\frac{1}{4}$
Burning Coal Vein rabbittbush stand	T136N R102W S14 NW $\frac{1}{4}$
Chase Lake	T141N R69W S19
Killdeer	T142N R95W S 13 & 24
Killdeer Mountains	T146N R96W S10
Marmath	T135N R106W S16, 21, 28
McLeod prairie*	T134N R53W S8 NE $\frac{1}{4}$
'Meg' hill (Slope Co.)	T136N R102W S14 NE $\frac{1}{4}$
Mineral Springs (Slope Co.)	T133N R100W S22
Mirror Pool (Ransom Co.)*	T136N R53W S36 SE $\frac{1}{4}$
Mirror Pool (Richland Co.)*	T135N R52W S4 SW $\frac{1}{4}$
Tongue River	
Game Management Area	T161N R56W S3 & 4
Turtle Mountains	T163N R76W S10 - 15
Walcott Dunes	T135N R51W S7, 8, 17, 18
White Buttes	T134N R101W S15 E $\frac{1}{4}$

Areas marked with an asterisk (\*) are places subject to change in the near future. The Mirror Pools will be totally submerged if the plans for the Kindred dam are implemented. The Alexander area as well as the McLeod prairie may be subjected to plowing or grazing.

## North Dakota Butterfly Calendar

Species	May	Jun	Jul	Aug	Sep	Oct	Comment
<i>Megathymus texanus leussleri</i> (H)	...	..*	*..	...	...	...	Badlands to Missouri R.
<i>Lerodea eufala</i> (Edwards)	...	...	...	..-	---	...	Rare southern migrant
' <i>Amblyscirtes simius</i> ' (Edwards)	...	..*	*..	...	...	...	May occur in Badlands
<i>Amblyscirtes oslari</i> (Skinner)	..*	*..	...	...	...	...	Badlands
<i>Amblyscirtes vialis</i> (Edwards)	..*	*..	...	...	...	...	Badlands & Turtle Mts
' <i>Amblyscirtes hegon</i> ' (Scudder)	..*	*..	...	...	...	...	Minnesota in woods
<i>Atrytonopsis hianna hianna</i> (Sc)	..*	*..	...	...	...	...	Dry prairies
<i>Euphyes dion dion</i> (Edwards)	...	...	..*	---	---	...	E ND in sloughs
<i>Euphyes vestris metacomet</i> (Harr)	...	..-	*..	---	---	...	Statewide
<i>Poanes massasoit massasoit</i> (Sc)	...	...	*..	---	---	...	Richland-Ransom Bogs
<i>Poanes hobomok</i> (Harris)	...	..*	...	...	...	...	Statewide near trees
' <i>Poanes taxiles taxiles</i> ' (Edw)	...	...	..*	---	---	...	Black Hills, S.D.
<i>Poanes viator viator</i> (Edw)	...	...	*..	---	---	...	Eastern sloughs
' <i>Ochlodes sylvanoides napa</i> ' (Edw)	...	...	...	..*	*..	...	Black Hills, S.D.
<i>Atrytone arogos iowa</i> (Scudder)	...	..-	*..	..-	...	...	E virgin prairies
<i>Atrytone delaware delaware</i> (Edw)	...	..*	*..	...	...	...	Statewide
<i>Atrytone delaware lagus</i> (Edw)	...	..*	*..	...	...	...	SW N.D.
<i>Atalopedes campestris</i> (Boisd)	...	..*	..-	..*	*..	..-	Southern migrant
<i>Wallengrenia egeremet</i> (Scudder)	...	..-	***	---	...	...	Richland-Ransom Co.
<i>Polites coras</i> (Cramer)	...	..*	***	---	---	...	Statewide
<i>Polites themistocles</i> (Latreille)	...	..*	***	...	...	...	Statewide
<i>Polites origines rhena</i> (Edw)	...	..*	*..	..-	...	...	SW uncommon
<i>Polites mystic dacotah</i> (Edw)	...	..*	***	..-	...	...	Statewide
<i>Hesperia uncas uncas</i> Edwards	...	..*	..*	*..	---	...	SW N.D.
<i>Hesperia comma assiniboia</i> (Lym)	...	..-	...	***	---	...	Statewide, prairies
' <i>Hesperia nevada</i> ' (Scudder)	...	..*	..-	*..	..-	...	May occur in NW ND
<i>Hesperia pahaska pahaska</i> Leuss.	...	..*	*..	...	...	...	SW N.D. - Badlands
<i>Hesperia leonardus pawnee</i> Dodge	...	...	...	..*	---	..-	Dry prairies
<i>Hesperia ottoe</i> Edwards	...	..*	*..	..-	...	...	Badlands
<i>Hesperia dacotae</i> (Skinner)	...	..*	*..	..-	...	...	E virgin prairies
' <i>Hesperia sassacus manitiboides</i> '	...	..*	..-	...	...	...	Minnesota woods
<i>Yvretta rhesus</i> (Edw)	..*	*..	..-	...	...	...	Badlands
<i>Oarisma powesheik</i> (Parker)	...	..*	*..	...	...	...	SE N.D.
<i>Oarisma garita</i> (Reakirt)	...	..*	..-	...	...	...	Statewide, but rare SE
<i>Ancyloxypha numitor</i> (Fabricius)	...	..*	*..	..*	*..	..-	E ND along water
<i>Carterocephalus paleomon mandan</i>	..*	*..	...	...	...	...	Turtle Mts-Pembina Hills
<i>Pholisora catullus</i> (Fab.)	...	..*	*..	---	*..	..-	Statewide
<i>Pholisora libya lena</i> (Edw)	...	...	..*	..-	...	...	Badlands
<i>Pyrgus scriptura</i> (Boisduval)	...	...	..*	..-	...	...	Badlands
<i>Pyrgus communis communis</i> (Grt)	...	..*	*..	..*	*..	---	Statewide, common late
<i>Erynnis icelus</i> (Sc & Burgess)	..*	*..	...	...	...	...	Turtle Mts-Pembina Hills
<i>Erynnis brizo brizo</i> (B. & Lec.)	..*	---	...	...	...	...	Turtle Mts-Pembina Hills
<i>Erynnis persius frederecki</i> Fmn	..*	*..	...	...	...	...	Western N.D. rare
<i>Erynnis lucilius afranius</i> (Lint)	..*	*..	..*	..-	...	...	SW - two broods
' <i>Erynnis martialis</i> ' (Scudder)	..-	*..	...	...	...	...	May occur in E N.D.
' <i>Erynnis horatius</i> ' (Scud. & Burg)	..-	---	...	..-	*..	...	May occur in SE N.D.
<i>Erynnis juvenalis juvenalis</i> (F.)	..*	***	...	...	...	...	Turtle Mts & SW
<i>Thorybes pylades</i> (Scudder)	..-	***	...	...	...	...	NE & Badlands
<i>Epagyreus clarus clarus</i> (Cram)	...	..*	..-	...	...	...	Statewides, mostly SW

Species	May	Jun	Jul	Aug	Sep	Oct	Comment
<i>Papilio polyxenes asterius</i> Stol	---	---	---	---	---	...	Eastern N.D.
<i>Papilio bairdii brucei</i> Edw	..-	..-	..*	*--	...	...	Badlands, high ridges
<i>Papilio zelicaon gothica</i> Reming	..*	*--	---	...	...	...	Badlands, high ridges
<i>Papilio cressphontes</i> Cramer	...	...	...	..-	...	...	Southern migrant, rare
<i>Papilio glaucus glaucus</i> L.	..-	***	..-	..-	..-	...	Statewide, uncommon
<i>Papilio glaucus canadiensis</i> R&J	..-	***	..-	...	...	...	Badlands, Turtle Mts
<i>Papilio rutulus rutulus</i> Lucas	..-	***	..-	...	...	...	Badlands, rare, sporadic
<i>Papilio multicaudatus</i> Kirby	..*	***	*--	...	...	...	SW N.D.
<i>Pieris sisymbrii elivata</i> B & B	..*	---	---	...	...	...	Harding Co., S.D.
<i>Pieris protodice protodice</i> B&L	..-	---	---	---	*--	---	Statewide, common
<i>Pieris rapae</i> (L.)	..-	***	***	***	***	*--	Statewide, common
<i>Colias eurytheme</i> Boisduval	..-	---	---	---	---	---	Statewide
<i>Colias philodice</i> Godart	---	---	---	---	---	---	Statewide
<i>Colias cesonia</i> (Stoll)	...	..-	..*	---	..-	...	Southern migrant
<i>Colias alexandra alexandra</i> Edw	...	..-	..-	*--	...	...	Badlands, two broods
<i>Phoebis sennae eubule</i> (L.)	...	..-	...	...	...	...	Southern migrant, rare
<i>Eurema mexicana</i> (Boisduval)	...	...	..-	...	...	...	Southern migrant, rare
<i>Eurema lisa</i> Boisduval & Lec.	...	..-	..-	...	...	...	Southern migrant
<i>Natholis iole</i> Boisduval	...	...	..-	---	..-	...	Southern migrant
<i>Euchloe olympia olympia</i> Edw	***	---	...	...	...	...	SW, rare in SE
<i>Mitoura siva siva</i> (Edw)	..*	***	..-	...	...	...	Badlands, on Juniper
<i>Strymon melinus hyperici</i> B & L	---	---	---	---	..-	...	S N.D. uncommon
<i>Harkenclenius titus titus</i> (Fab)	...	...	***	---	...	...	Statewide near plum
<i>Satyrrium calanus</i> (Godart)	...	...	*--	---	...	...	Vicinity of Oak SE, N
<i>Satyrrium edwardsii</i> (Grt & Rob)	...	...	*--	..-	...	...	Vicinity of Oak SE, N
<i>Satyrrium acadica</i> (Edw)	...	...	***	*--	...	...	Statewide near willows
<i>Satyrrium liparops fletcheri</i> (M)	...	...	***	..-	...	...	Statewide, uncommon
<i>Lycaena hyllus</i> (Cramer)	...	..-	***	*--	..-	...	Mostly E ND - low areas
<i>Lycaena xanthoides dione</i> Scud.	...	..*	*--	...	...	...	Statewide
<i>Lycaena rubidus sirius</i> (Behr)	...	..*	*--	...	...	...	SW - low areas
<i>Lycaena helleoides helleoides</i> (B)	...	..-	---	---	..-	...	Statewide
<i>Plebejus melissa melissa</i> (Edw)	...	***	*--	..*	*--	..-	Statewide
<i>Plebejus saepolius amica</i> (Edw)	...	***	..-	...	...	...	S N.D. esp. Badlands
<i>Plebejus acmon</i> (Westwood & Hew)	...	***	***	*--	..-	...	SW N.D.
<i>Plebejus shasta minnehaha</i> (Scud)	...	*--	...	...	...	...	Badlands, rare
<i>Hemiargus isola</i> (Reakirt)	...	...	...	---	---	---	Southern migrant, rare
<i>Feniseca tarquinius</i> (Fab)	..*	...	..-	*--	...	...	Pembina Hills
<i>Everes comynta</i> (Godart)	---	---	---	---	---	---	Eastern N.D.
<i>Everes amyntula</i> (Boisduval)	---	---	---	---	---	---	N & W N.D.
<i>Glaucopsyche lygdamus oro</i> Sc.	..**	*--	...	...	...	...	Statewide, esp SW & NE
<i>Celestrina argiolus lucia</i> (Kby)	***	*--	***	---	---	..-	Statewide
<i>Callophrys sheridanii</i> (Edw)	**	...	...	...	...	...	McKenzie Co.
<i>Incisalia eryphon</i> (Boisduval)	..**	*--	...	...	...	...	Ponderosa Pine in SW
<i>Incisalia polios obscurus</i> Ferr.	..**	..-	...	...	...	...	Killdeer Mts
<i>Apodemia mormo mormo</i> (Felder)	...	...	...	***	---	---	Badlands
<i>Libytheana bachmanii bachmanii</i>	...	...	..-	..-	...	...	Southern migrant
<i>Asterocampa celtis celtis</i> (B & L)	..*	*--	...	...	...	...	E ND near Hackberry
<i>Asterocampa clyton clyton</i> (B & L)	...	..-	***	...	...	...	E ND near Hackberry
<i>Limenitis arthemis arthemis</i> (Dr)	...	***	*--	---	..-	...	E N.D. & Turtle Mts
<i>Limenitis arthemis astyanax</i> (F)	...	***	---	---	...	...	SE N.D.
<i>Limenitis archippus archippus</i> (C)	..-	***	---	***	---	...	Mostly S & E
<i>Limenitis weidemeyeri oberfoellii</i>	..*	---	...	...	...	...	SW N.D.

Brown



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## OBSERVATIONS OF PREDATION ON LEPIDOPTERA IN ALASKA

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DURING THE SUMMER OF 1975, J. W. and Hazel I. Tilden spent several weeks of field work in Alaska, mostly in the north-central area, and on several occasions noted predation on butterflies and moths by both birds and predatory insects.

Along the Steese Highway, and along roads in the vicinity of Fairbanks, unbelievable numbers of the geometrid moth, *Eulype hastata* (L.), assembled on the moist soil of roadside ditches. Often the surface was gray with them, and they were sitting so close together that their wings touched. When disturbed they fluttered up in clouds. Birds, particularly robins, were observed to gather beakfuls of these moths, fly away, presumably to their nests, and return shortly to take more.

Robins, wheatears, and lapland longspurs were frequently noted foraging on the open tundra, and returning from time to time to their nests with beakfuls of insects, including both moths and butterflies. On different occasions, these birds were seen to forage a short distance in front of us, as though waiting to capture such insects as we might disturb. At Eagle Summit, on the Steese Highway, a specimen of *Erebia youngi* Holland was taken that showed a well-defined beak mark on its left forewing, and a specimen of *Erebia epipsodea* showed a beak mark and some tearing, on the left hindwing.

While collecting at Ester Dome, in the vicinity of Fairbanks, Hazel Tilden disturbed a specimen of *Boloria* (Nymphalidae) which flew a short distance and settled. She noted a large wasp fly by, and saw the butterfly rise slightly and settle again. When she reached the spot where she had marked the butterfly down, she found that the wasp had caught the butterfly and was tearing it to pieces. Both the wasp and the butterfly prey were collected and preserved. The wasp proved to be a female of *Vespula arenaria* (Fabricius). The butterfly is a specimen of *Boloria chariclea butleri* (Edwards).

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## SIGNIFICANT ADDITIONS TO THE LEPIDOPTEROUS FAUNA OF SOUTHEASTERN ONTARIO

J. C. E. RIOTTE, M.A.<sup>1</sup>

IN VOL. 13 (1) OF THIS JOURNAL, Ward, Harmsen and Hebert published their annotated checklist of the macrolepidoptera of southeastern Ontario.

An interesting addition to the species treated in this list is the arctiid *Epantheria scribonia* (Stoll), previously known in Canada only from southwestern Ontario. There are a few specimens from localities like London, Hamilton, Niagara Falls and Walsingham, i.e. localities on the north shore of L. Erie, an area well known to be representative of Carolinian zone fauna in Ontario. The new specimen was captured at light at Queen's University Biology Station, Chaffeys Locks, Leeds Co., on 22 June 1975, by J. J. Bellwood. Together with the following records and with well known botanical facts (Hainault, 1966), this substantiates the faunal identity of the easternmost part of L. Ontario to the north shore of L. Erie.

Another species belonging to the southern insect fauna is *Cisthene plumbea* Stretch which is already mentioned in the "checklist" and was captured twice at the Station in Chaffeys Locks, in 1963 and again 1967. It is also an arctiid (Lithosiinae). The other Ontario locality for the species is London.

In the Limacodidae, a surprising "newcomer," *Sisyrosea textula* (Herrich-Schäffer), was captured at the superactinic light on 25 July 1974 at the Station. Otherwise the species is known from Dunnville, Rondeau Prov. Park, St. Williams and Dundas nr. Hamilton, all on the north shore of L. Erie.

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An impressive additional piece of evidence was the discovery in 1974 of a small colony of skippers (Hesperiidae). In 1974, *Atrytonopsis hianna* (Scudder), was taken for the first time in eastern Ontario on a roadside near Stoco, Hastings Co. The species was known previously only from a few localities on the southeast shore of L. Huron, like Sarnia and Pinery Prov. Park. The date of capture was 28 June 1974.

The question is: do we have here single, accidental records or do these data indicate a movement of insects from the south to the north because of changing climatic conditions (Urquhart, 1957)?

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HABITAT: *PIERIS OCCIDENTALIS NELSONI*  
(PIERIDAE)

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NELSON'S WHITE, *Pieris occidentalis nelsoni* W. H. Edwards, is the Alaskan subspecies of the widespread Western White and appears to represent a phenotypic transition to the Palearctic taxon *P. callidice* Hübner, whose range has recently been extended to northeastern Siberia (K. Philip, *pers. comm.*). Like Californian *P. o. occidentalis* Reakirt and lowland *P. protodice* Boisduval and LeConte, *P. o. nelsoni* is preadapted to the highly disturbed habitats created by man (compare Shapiro 1975a,b,c). The photographs offer two views of the east end of the railroad yard complex at Fairbanks, Alaska, where *P. o. nelsoni* was found commonly in July 1974. The highly disturbed sandy soil supports a large stand of the weed annual Crucifer *Lepidium densiflorum* Schrad. var. *bourgeauanum* (Thell.) C. L. Hitchc. on which the butterfly was breeding. Larvae of *Euchloe ausonides* Lucas were also found here on this plant. *Pieris napi* L. occurred in the nearby forest and occasionally ventured into the railroad yard, but did not appear to be breeding there. Other butterflies found in the railroad yard were *Colias gigantea* Strecker, *C. philodice* Latreille, *Lycaena helloides/dorcas* complex, *Plebeius saepiolus* Boisduval, and *Limenitis arthemis* Drury.

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Fig. 1.—Railroad yard at Fairbanks, Alaska, looking east. Virtually the entire area from the trees at left to the road is a solid stand of *Lepidium densiflorum*.





Fig. 2.—Same area, looking south. In broken cloudiness *P. occidentalis nelsoni* thermoregulatory behavior was readily observed on bare soil among *Lepidiums*, foreground.

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## BUTTERFLY COLLECTING IN LABRADOR AND NEWFOUNDLAND

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In a previous article (Ferris, 1974), observations on arctic collecting were reported, but little was mentioned about the eastern arctic. During July, 1975, the author collected extensively in Newfoundland and Labrador. Although somewhat expensive, travel to these areas now is quite easy, and some of my experiences are presented here.

Both Gander on the main island of Newfoundland and St. John's in the Avalon Peninsula are served by Air Canada jets from various points in Canada and the U.S. Boston is a convenient departure point. Newfoundland is well connected by paved roads. The principal one is Hwy. 1, the Transcanada Highway, which links St. John's in the southeast and Channel-Port-aux-Basques 565 miles away on the southwest coast, passing through Gander, Grand Falls, Deer Lake, and Corner Brook on the way. Numerous secondary roads, many paved, permit access to coastal and bay areas including St. Anthony on the northern tip of Newfoundland. Rental cars are available from three major and several smaller auto rental agencies.

One can travel from Newfoundland to Labrador by air or ship. The Canadian National Railway system operates summer passenger boat service from St. John's, Lewisporte, and other ports in Newfoundland to ports in Labrador as far north as Nain (ca. 57° N). This service typically begins from early to mid-July depending upon breakup of the arctic ice. Eastern Provincial Airways jets connect St. John's, Gander, and Deer Lake, Nfld. with Goose Bay and several other communities in southern Labdr. Labrador Airways, Ltd. serves Hopedale, Davis Inlet, and Nain by twice-a-week float planes. Charter flights are

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available to other areas. These flights, however, are strongly dependent upon weather conditions, and one should plan on alternative travel by ship if possible. During forest fire season, flights are curtailed, and the company generally caters to the charter trade over the regularly scheduled passengers. Nain is the northern most community regularly served by air or ship.

For those wishing to drive from the States to Newfoundland (not Labrador), one can drive to Nova Scotia via Maine and New Brunswick. Car ferry service (Canadian National Railways) is available from Sidney, N.S. to Channel-Port-aux-Basques, Nfld. Unless one has unlimited time, driving is not recommended.

Housing can be a problem. Motels and tourist homes abound in Newfoundland, but Labrador is another matter. There is a basic, but expensive, hotel at Goose Bay, but the smaller communities presently offer no tourist services. One must make boarding arrangements with individual families. Usually contacts can be made through the proprietor of the general store in the community of interest. Such arrangements, however, should be made well in advance. There is a "motel" and club proposed for Nain which should be in operation by 1976. Of course, camping is possible, and one may camp almost anywhere in the countryside.

Sanitation and water supply are also a problem in some of the smaller communities. Individuals prone to intestinal disorders are well advised to boil or treat drinking water. Because provisions come into northern Labrador only in the summer by freighter, the diet is rather limited. Anyone requiring special foods best check in advance on their availability.

As with most subarctic and arctic areas, the weather is extremely variable in Newfoundland and Labrador, so that the collector should allow himself several weeks for a trip. The main season is from mid-June to early August. The season normally begins a bit later in Labrador with the last two weeks in July as perhaps the optimum collecting period generally in northern Labrador.

A number of species can be taken in Newfoundland, but at any given locality in Labrador, only a rather limited number are to be found. In northern Labrador, there appears to be substantial variation from year-to-year in what flies, and it should be noted that *Boloria polaris* and *Oeneis jutta* fly during even-numbered years. For example, extensive collecting at Nain in

1975 yielded only ten species. About 15-16 species are variously recorded from Nain. The author had no previous records for three of the species taken. Weather conditions were excellent for the most part.

While travel to Newfoundland and Labrador is relatively easy, one should recognize that it is expensive and that the number of species taken may be quite limited. Another phenomenon noted was that butterflies occurred in very local colonies, and were not generally distributed as is the case in much of the western arctic. Butterflies were abundant in a given locale, while seemingly identical habitats a mile distant were barren.

Much of the terrain in Labrador is covered by dry caribou moss and scrub. The larval foodplants associated with butterflies are absent. For this reason, one should choose travel destinations rather carefully to avoid arriving at a "dry" area. Generally speaking, butterflies were not nearly so abundant as in the western arctic.

As opposed to the western arctic, butterflies do fly on overcast days in both Labrador and Newfoundland. On clear days, they were observed on the wing from 9 am ADT until 5 pm ADT, and flew for a shorter period on overcast days.

Collecting in Newfoundland and Labrador can be quite rewarding, but plans for travel and housing should be made well in advance. It is essential that sufficient time be allowed for the trip to accommodate the weather and changes in air travel schedules.

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Continued from 15(1):41-60

## SUBFAMILY Heliconiinae

All of the members of this subfamily possess yellowish abdominal scent glands (the glands being more highly developed in the female of each species and in the members of the genus *Heliconius*). These glands are everted when the butterflies are disturbed and emit acrid odors.

116. *Philaethria dido dido* (Clerck)

SPECIMENS: 4 ♂♂, 2 ♀♀; 900, 1,900 feet; 12 July-26 Oct.

This large green and black species is common in the *Pinus-Quercus* Associates of the Deciduous Woodland during the fall months. The butterflies were seen most frequently as they flew around the bright green foliage of mango and citrus trees or as they visited the flowers of cultivated marigolds (*Tagetes* sp.) in the Indian villages. The flight is relatively slow, weak, and usually between ten and 20 feet of the ground.

117. *Dryadula phaetusa* (Linnaeus)

SPECIMENS: 8 ♂♂, 3 ♀♀; 1,100-2,100 feet; 1 July-28 Sept.

This heliconian is common in Pastures, Recently Abandoned Milpas and along Hedgerows in the Catemaco Basin and along the coast but uncommon in most other localities. The butterflies are attracted to the blossoms of *Lantana camara*. The flight is of a moderate velocity and usually about four feet above the ground.

118. *Agraulis vanillae incarnata* (Riley)

SPECIMENS: 7 ♂♂, 2 ♀♀; 0-2,700 feet; 21 June-23 Oct.

The Gulf fritillary is abundant in the Littoral Woodland along the coast and common to uncommon in Pastures and Recently Abandoned Milpas in other sections of the range. The butterflies are attracted to the flowers of *Lantana camara*. The flight is slightly slower than that of the previous two species and usually between one and three feet of the ground.

119. *Dione juno huascama* (Reakirt)

SPECIMENS: 10 ♂♂, 5 ♀♀; 0-5,100 feet; 5 May-29 Oct.

This species is common to abundant in Pastures, Recently Abandoned Milpas and along Hedgerows in the Catemaco Basin but uncommon in most other localities. All specimens were collected on the blossoms of *Lantana camara*. The flight is similar to that of *Agraulis vanillae*.

120. *Dione moneta poeyii* (Butler)

SPECIMENS: 10 ♂♂; 4,700-5,400 feet; 2 March-26 Aug.



This species is common only above the canopy of the Elfin Woodland on the peaks of the major volcanoes. When collected, the butterflies were "hill topping."

121. *Dryas julia julia* (Fabricius)

SPECIMENS: 6 ♂♂, 7 ♀♀; 500-5,400 feet; 3 March-25 Aug.

The julia is common to abundant in most open, sunny areas regardless of plant formation. The species is the most common and widely distributed heliconian excepting the genus *Heliconius*. The flight is less rapid and usually nearer the ground than that of the preceding species.

122. *Heliconius (Eueides) cleobaea zorcaon* (Reakirt)

SPECIMENS: 14 ♂♂, 12 ♀♀; 0-2,300 feet; 11 Feb.-23 Oct.

This species is abundant and the most common heliconian in the Sierra, being found in or along the margins of all formations except the Montane Rain Forest, Montane Thicket, and Elfin Woodland. The flight is slow, relatively weak, and usually between three and six feet of the ground. The larval food plants are *Passiflora ambigua* in the Ocotal Chico region and *P. serratifolia* in the Catemaco Basin. Immature stages are described in Ross (1964d).

123. *Heliconius (Semelia) vibilia vialis* (Stichel)

SPECIMENS: 2 ♀♀; Vigía, 1,750 feet, 5 Aug. 1963, 1 ♀; Ocotal Chico, 1,900 feet, 28 Oct. 1962, 1 ♀.

This butterfly is rare; one female was collected as it fed on the blossoms of *Cephaelis elata* along a trail in the Lower Montane Rain Forest and the other as it fed on marigolds in a village garden.

124. *Heliconius (Semelia) lineata* (Salvin & Godman)

SPECIMENS: 9 ♂♂, 5 ♀♀; 700-5,100 feet; 26 May-19 Oct.

*H. lineata* is locally common and found primarily along the borders of the Semi-Evergreen Seasonal Forest and Lower Montane Rain Forest. Several specimens were collected as they fed on the flowers of *Cordia alliodora*, a white flowering shrub that is common in most fields and along the borders of forests. The flight is relatively slow, weak, and approximately ten to 15 feet above the ground.

125. *Heliconius (Semelia) aliphera gracilis* (Stichel)

SPECIMENS: 7 ♂♂, 3 ♀♀; 900-1,900 feet; 22 June-28 Sept.

This species is more common and less local than the preceding, being found most frequently in Pastures, Recently Abandoned Milpas and along Hedgerows and open, sunny road sides. Most specimens were collected as they fed on the white flowers

of *Bidens pilosa* var. *bimucronata*. The flight is relatively slow, weak, and usually within three or four feet of the ground.

126. *Heliconius (Heliconius) ismenius telchinia* Doubleday

SPECIMENS: 14 ♂♂, 10 ♀♀; 0-3,500 feet; 27 Feb.-5 Oct.

This large heliconian is abundant in all formations except the Montane Thicket, Elfin Woodland, Savanna, Deciduous Woodland (including the *Pinus-Quercus* Associates). The flight is relatively slow, weak, and approximately between six and eight feet of the ground. The butterflies seem to prefer partially shaded areas.

127. *Heliconius (Heliconius) doris transiens* Staudinger

SPECIMENS: 22 ♂♂, 4 ♀♀; 10-2,900 feet; 17 May-26 Oct.

This black and red species is locally abundant, the butterflies being found most frequently in sunny glades within the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest. The butterflies are attracted to the orange flowers of the vine *Anguria tabascensis*.

128. *Heliconius (Heliconius) sapho leuce* Doubleday

SPECIMENS: 31 ♂♂, 8 ♀♀; 700-3,200 feet; 17 March-29 Oct.

This blue and white heliconian is abundant only in the Lower Montane Rain Forest and Montane Rain Forest (including the *Liquidambar-Quercus* Associates) on the Santa Marta massif. The flight is relatively slow, weak, and usually between four and ten feet of the ground in sunny glades and along bright trails. The butterflies are attracted to the blossoms of *Anguria tabascensis*.

129. *Heliconius (Heliconius) sara veraepacis* Bates

SPECIMEN: 1 ♀; 0.25 mi. S Ocotil Grande, 1,800 feet, 15 May 1965.

This species is rare; the single female was collected in a coffee finca in the Lower Montane Rain Forest. The butterfly was flying approximately nine feet above the ground in the company of two individuals of *Heliconius doris*.

130. *Heliconius (Heliconius) petiveranus* Doubleday

SPECIMENS: 14 ♂♂, 4 ♀♀; 0-2,300 feet; 23 April-25 Oct.

*Heliconius petiveranus* is abundant in or along the margins of all formations except the Montane Rain Forest, Montane Thicket, and Elfin Woodland. The flight is extremely weak, in fact, the weakest of that of all species of *Heliconius* collected, and usually within two feet of the ground. The larval food plants are *Passiflora biflora* in the Ocotil Chico region and Catemaco Basin, and *P. coriacea* in the Catemaco Basin also. The immature stages have been described in Ross (1964d).

131. *Heliconius (Heliconius) charitonius vazquezae* Comstock & Brown

SPECIMENS: 6 ♂♂, 4 ♀♀; 700-1,800 feet; 16 Feb.-16 Sept.

The zebra is common to abundant in or along the margins of all formations except the Montane Thicket and Elfin Woodland. This species seems to prefer sunny, open areas more than do the other members of the subgenus *Heliconius*. The flight is relatively slow, weak, and usually between three and six feet of the ground.

132. *Heliconius (Heliconius) hortense* Guérin

SPECIMENS: 10 ♂♂, 5 ♀♀; 1,800-5,100 feet; 17 June-14 Oct.

This heliconian is uncommon and found only in the Montane Thicket, Elfin Woodland, and Montane Rain Forest. The butterflies were collected most frequently as they flew in sunny glades and along bright trails. The flight is relatively rapid and usually between two and five feet of the ground.

SUBFAMILY Nymphalinae

TRIBE Argynididi

133. *Euptoieta hegesia hoffmanni* Comstock

SPECIMENS: 5 ♂♂, 5 ♀♀; 1,100-2,200 feet; 6 June-28 Oct.

The Mexican fritillary is abundant in most sunny, open areas regardless of plant formation. The butterflies visit the flowers of a variety of plants. The flight is of moderate velocity and usually between two and three feet above the ground. The larval food plant is *Turnera ulmifolia*, a small plant that is common in sunny areas within the pine-oak forest and other relatively open areas on the Santa Marta massif. Ross (1964d) described the egg.

134. *Chlosyne janais* (Drury)

SPECIMENS: 12 ♂♂, 13 ♀♀; 0-2,000 feet; 18 March-18 Sept.

This relatively large *Chlosyne* is abundant in Pastures, Recently Abandoned Milpas, Littoral Woodland, Semi-Evergreen Seasonal Forest, and the Lower Montane Rain Forest when the larval food plant *Odontonema callistachyum* is present. The butterflies are particularly abundant in the pastures along the coast. The flight is relatively weak and interrupted by frequent gliding periods. Immature stages are described in Ross (1964d).

135. *Chlosyne hippodrome* (Geyer)

SPECIMENS: 15 ♂♂, 7 ♀♀; 500-2,200 feet; 30 June-31 Oct.

*Chlosyne hippodrome* is uncommon to common and found most frequently along sunny road sides and in Pastures and

Recently Abandoned Milpas. The butterflies visit the flowers of composites, particularly *Melampodium kunthianum* and *Baltimora recta*, very frequently. The behavior of *C. hippodrome* is different from that of the other four species of *Chlosyne* collected—the flight is slower with relatively uninterrupted wing beats and usually between seven and 15 feet above the ground. In addition, the butterflies visit mud puddles very infrequently.

136. *Chlosyne lacinia lacinia* (Geyer)

SPECIMENS: 14 ♂♂, 5 ♀♀; 1,100-2,700 feet; 20 June-25 Sept.

Scudder's patched butterfly is abundant (more abundant than *C. janais*) in most sunny, open areas throughout the range where flowers occur. The flight is similar to that of *C. janais*. The butterflies are attracted to mud puddles and flowers. One of the 19 specimens collected is almost totally dark and appears to be the morphotype named form *ardema* Reakirt.

137. *Chlosyne erodyle* (Bates)

SPECIMENS: 6 ♂♂, 7 ♀♀; 500-2,200 feet; 20 June-23 Oct.

This species is common only in grassy-shrubby fields within the Deciduous Woodland and the *Pinus-Quercus* Associates and several Recently Abandoned Milpas on the SSW slope of Volcán San Martín Tuxtla. Thus, the species seems to prefer slightly higher elevations than do the other species of *Chlosyne*. The behavior is very similar to that of *C. janais* and *C. lacinia*.

138. *Chlosyne definitiva* Aaron

SPECIMEN: 1 ♀; 1.25 mi. N Ocotil Chico, 2,300 feet, 26 July 1963.

This species is rare; the single female was taken as it fed on *Calea longipedicellata* in the *Pinus-Quercus* Associates of the Deciduous Woodland.

139. *Thessalia theona theona* (Ménétriés)

SPECIMENS: 16 ♂♂, 7 ♀♀; 0-4,700 feet; 17 March-4 Oct.

This checker spot is locally abundant and found in colonies in most open, sunny grassy areas, but particularly those within the Savanna, and Deciduous Woodland (including the *Pinus-Quercus* Associates). The flight is relatively rapid, erratic, and usually within two feet of the ground—very much like that of *Phyciodes* spp.

140. *Phyciodes (Phyciodes) vesta* (Edwards)

SPECIMENS: 6 ♂♂, 7 ♀♀; 1,050-1,900 feet; 17 June-13 Nov.

The vesta crescent is common in most open, sunny areas regardless of plant formation. The flight is of moderate velocity, rather erratic, and usually within two feet of the ground. The



butterflies are attracted to the flowers of a variety of plants. The species is represented in the Sierra by the morphotype known as form *bucardi* Godman & Salvin.

141. *Phyciodes (Eresia) frisia tulcis* (Bates)

SPECIMENS: 10 ♂♂, 4 ♀♀; 1,050-1,700 feet; 27 June-28 Sept.

The Cuban crescent is common and found primarily in Pastures and Recently Abandoned Milpas in the Catemaco Basin. The behavior is similar to that of *P. vesta*, which is typical of most members of the genus.

142. *Phyciodes (Eresia) claudina guatemalena* (Bates)

SPECIMENS: 7 ♂♂, 7 ♀♀; 75-2,600 feet; 6 Feb.-19 Oct.

This species is abundant in most open, sunny areas, particularly along the margins of Hedgerows and the Semi-Evergreen Seasonal Forest. The flight is slightly slower and weaker than that of most species of *Phyciodes* but similar to that of several heliconians—particularly *Dryas julia* and *Heliconius aliphera*, both of which are sympatric with *P. claudina guatemalena*.

143. *Phyciodes (Eresia) phillyra* (Hewitson)

SPECIMENS: 15 ♂♂, 11 ♀♀; 700-2,700 feet; 14 July-19 Oct.

This dimorphic species is locally common in and along the margins of the Lower Montane Rain Forest and the Semi-Evergreen Seasonal Forest and also in Recently Abandoned Milpas. The males were collected most frequently in the semi-shaded areas along the margins of forests and in sunny fields providing forest cover was near; the flight is rapid and erratic, very similar to that of the heliconians *Dione juno* and *Agraulis vanillae*. The females were found most frequently in shaded areas just within the forests; the flight is very slow and weak, very similar to that of several ithomiids and polymorphines. Both sexes are attracted to flowering composites, particularly *Bidens pilosa* var. *bimucronata*, which is common in fields and along the margins of forests.

144. *Phyciodes (Tritanassa) atronia* (Bates)

SPECIMENS: 4 ♂♂, 2 ♀♀; 1,500-2,200 feet; 24 Aug.-19 Oct.

This crescent is locally common in Recently Abandoned Milpas and Pastures. During the summer I found individuals feeding on blossoming composites only in several fields on the SSW slope of Volcán San Martín Tuxtla. However, later in the year (fall) I found the species at lower elevations in several fields in the vicinity of Sontecomapan. The behavior is typical of most members of the genus.

145. *Phyciodes (Tritanassa) ardys ardys* Hewitson



SPECIMENS: 10 ♂♂, 3 ♀♀; 1,100, 1,800 feet; 20 June-23 Oct.

This crescent is common—principally in the Catemaco Basin—in Recently Abandoned Milpas and Pastures. The behavior is similar to that of most species of *Phyciodes*.

146. *Phyciodes (Tritanassa) eranites mejicana* (Roeber)

SPECIMEN: 1 ♀; 2.5 mi. SW Sontecomapan, 1,500 feet, 19 Oct. 1962.

This species is rare; the single specimen was collected as it fed on the yellow blossoms of *Baltimora recta*, which was growing in a pasture bordered by Lower Montane Rain Forest.

147. *Phyciodes (Tritanassa) myia* (Hewitson)

SPECIMENS: 13 ♂♂, 14 ♀♀; 800-2,700 feet; 15 May-18 Oct.

*Phyciodes myia* is locally abundant, being found principally in Pastures and Recently Abandoned Milpas and along sunny road sides. The largest concentration of butterflies was found on the peak of Cerro Tuxtla. The butterflies visit the flowers of *Melampodium kunthianum*, *Bidens pilosa* var. *bimucronata*, and *Baltimora recta* very frequently. The behavior is typical of most species of *Phyciodes*.

148. *Phyciodes (Tritanassa) griseobasolis* Roeber

SPECIMENS: 9 ♂♂, 4 ♀♀; 1 mi. SE Sontecomapan, 700 feet, 14 July 1962; 1 ♂: 3 mi. SW Sontecomapan, 1,600 feet, 1 Oct. 1962, 3 ♂♂: 2.5 mi. SW Sontecomapan, 1,700 feet, 18 Sept. 1962, 1 ♂, 3 ♀♀: 8 mi. SSE Catemaco, 1,950 feet, 29 Sept. 1962, 1 ♂: 3 mi. W Santiago Tuxtla, 2,100 feet, 22 June 1962, 1 ♂; 2,700 feet, 22 June 1962, 2 ♂♂, 1 ♀.

This species, which is a sibling of *P. myia*, is locally abundant (but slightly less so than the sibling) in Pastures and Recently Abandoned Milpas and along sunny road sides. Both species appear to be completely sympatric. In fact, the largest concentration of *P. griseobasolis* was found also on the peak of Cerro Tuxtla. The behavior is typical of most members of the genus. The nearest recorded locale for *P. griseobasolis* (= *P. ofella*) is the "Oriente & Sur de Chiapas" (Hoffmann, 1940).

149. *Phyciodes (Tritanassa) clara* (Bates)

SPECIMEN: 1 ♀; 2.5 mi. SW Sontecomapan, 1,300 feet, 6 Aug. 1962.

This crescent is rare; the single female was collected along the margin of the Lower Montane Rain Forest. The butterfly was resting on a leaf approximately three feet above the ground.

## TRIBE Nymphalini

150. *Polygonia g-argenteum* (Doubleday & Hewitson)

SPECIMENS: 2 ♀ ♀ ; 2.5 mi. SW Sontecomapan, 1,200 feet, 18 Nov. 1962.

This angle wing is rare and was collected in the Lower Montane Rain Forest. The two females were given to me by a local collector (Abraham Ramírez) who supposedly collected them in trap nets (rotting bananas being used as bait).

151. *Vanessa virginiensis* (Drury)

SPECIMENS: 11 ♂ ♂ , 6 ♀ ♀ ; 1,900-5,400 feet; 16 June-30 Oct.

The painted lady is locally common and found principally in the Elfin Woodland and the *Pinus-Quercus* Associates of the Deciduous Woodland. Most specimens were collected as they engaged in "hill-topping" over the high peaks and knolls within the range, particularly Cerro Tuxtla. However, individuals occasionally were seen as they rested on the red dirt trails within the pine-oak forest. The flight is of moderate velocity, erratic, and usually between four and 15 feet of the ground.

152. *Junonia evarete evarete* (Cramer)

SPECIMENS: 3 ♂ ♂ , 10 ♀ ♀ ; 1,100-2,700 feet; 17 March-26 Oct.

The buckeye is fairly common along roads and trails in the Deciduous Woodland and the *Pinus-Quercus* Associates. The butterflies were collected most frequently as they rested on sunlit bare soil with their wings held in horizontal positions. The flight is rather rapid, erratic, and usually of short duration.

153. *Anartia jatrophae luteipicta* Fruhstorfer

SPECIMENS: 8 ♂ ♂ , 4 ♀ ♀ ; 0-2,700 feet; 11 Nov.-27 Aug.

The white peacock is common in most open, sunny areas regardless of plant formation, but especially at lower elevations. The butterflies are attracted to a variety of flowering plants. The flight is relatively slow and usually between one and three feet of the ground.

154. *Anartia fatima venusta* Fruhstorfer

SPECIMENS: 5 ♂ ♂ , 5 ♀ ♀ ; 0-1,800 feet; 27 Feb.-28 Aug.

The fatima is the most abundant and widely distributed butterfly in the Sierra, being found in practically all open and sunny areas regardless of plant formation. The behavior is similar to that of the preceding species. Two specimens collected in

the spring have the ventral surfaces of their wings coated with brown scales.

155. *Metamorpha stelenes biplagiata* (Fruhstorfer)

SPECIMENS: 14 ♂♂, 2 ♀♀; 1,100, 1,200 feet; 21 June-8 Oct.

The malachite is common along the margins of the Semi-Evergreen Seasonal Forest and along Hedgerows in the vicinity of Lago Catemaco. Most butterflies were collected as they fed on the fermenting juices of fallen mangos and figs (*Ficus padifolia*). The specimens collected in August, September, and October, have the ventral surfaces of their wings coated with silvery scales; this morphotype has been named form *pallida* Fruhstorfer. The flight is characteristic of most species of nymphalines—rather rapid, erratic, and usually between five and ten feet of the ground.

156. *Metamorpha epaphus* (Latreille)

SPECIMENS: 3 ♂♂, 6 ♀♀; 1,100-2,450 feet; 3 March-20 Sept.

This species is common in Recently Abandoned Milpas on the SSW slope of Volcán San Martín Tuxtla but uncommon in all other locales. Most butterflies were collected as they fed on the blossoms of unidentified tall yellow composites. The flight is of moderate velocity and usually relatively high—approximately between 12 and 20 feet above the ground.

157. *Hypanartia lethe* (Fabricius)

SPECIMENS: 4 ♂♂, 2 ♀♀; 1,100-1,950 feet; 24 June-18 Nov.

*H. lethe* is uncommon and found most frequently along the margins of the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest. The butterflies were collected as they fed on *Bidens pilosa* var. *bimucronata* and as they rested in head downward positions on leaves of trees and bushes. The flight is similar to that of most members in the tribe Nymphalini.

158. *Hypanartia dione* Latreille

SPECIMENS: 1 ♂, 1 ♀; 3 mi. NNW Ocotil Chico, 5,000 feet, 15 June 1965, 1 ♀: Peak Volcán Santa Marta, 5,100 feet, 6 June 1965, 1 ♂.

This species is rare and found only in the Elfin Woodland on Volcán Santa Marta. Both specimens were collected as they rested on bare soil on ridge slopes that recently had been defoliated by landslides (two additional butterflies were seen in these same areas). The flight is very rapid, erratic, and between two and five feet of the ground.

## TRIBE Biblini

159. *Biblis hyperia aganisa* Boisduval

SPECIMENS: 2 ♂♂, 7 ♀♀; 1,100-2,600 feet; 12 March-5 Oct.

This nymphalid is common and found principally along the margins of the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest and along Hedgerows. The butterflies seem to prefer partially shaded areas. The flight is very weak, slow, and usually within one or two feet of the ground. The blossoms of *Lantana camara* are attractive to the species.

## TRIBE Eunicidi

160. *Mestra amymone* (Ménétriés)

SPECIMENS: 8 ♂♂, 5 ♀♀; 500-1,900 feet; 9 June-18 Oct.

The amymone is abundant in the Savanna, Deciduous Woodland and the *Pinus-Quercus* Associates, Recently Abandoned Milpas, and Pastures and along Hedgerows on the Santa Marta massif but common to uncommon in most other sections of the range. The flight is very slow, weak, and usually between one and three feet of the ground.

161. *Pyrrhogyra hypensor* Godman & Salvin

SPECIMENS: 2 ♂♂, 11 ♀♀; 0-2,700 feet; 16 June-18 Aug.

This butterfly is common along the margins of the Swamp Forest but uncommon in all other formations. Most specimens were collected as they rested on leaves between five and ten feet of the ground along the banks of the Río Carizal. The flight is similar to that of most species in the family.

162. *Pyrrhogyra edocla aenaria* Fruhstorfer

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 7 Aug. 1962.

This species is rare; the single male was collected as it flew along the sunny driveway of the Hotel Playa Azul. The flight is similar to that of most other nymphalids.

163. *Pyrrhogyra otolais neis* Felder

SPECIMENS: 7 ♂♂, 20 ♀♀; 0-2,500 feet; 19 May-18 Nov.

This butterfly is common and the most common species of *Pyrrhogyra* in the Sierra; the species is found most commonly in the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, Swamp Forest, Mangrove Woodland, and along Hedge Rows. The butterflies habitually rest on leaves between three and ten feet above the ground. When an individual is disturbed, it flies very rapidly and erratically upward into the canopy but after a few minutes returns to the same perch or to one nearby.

164. *Pseudonica flavilla canthara* (Doubleday)

SPECIMENS: 3 ♂♂, 6 ♀♀; 1,100-2,550 feet; 20 Feb.-18 Oct.

This nymphalid is uncommon; all butterflies were found along the margins of the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Hedgerows. The flight is typical of most members of the family.

165. *Temenis laothoe liberia* (Fabricius)

SPECIMENS: 4 ♂♂, 6 ♀♀; 150-1,625 feet; 9 July-19 Oct.

This species is uncommon, being found only along the margins of the Semi-Evergreen Seasonal Forest. When collected, the butterflies were resting on leaves approximately two to five feet above the ground.

166. *Epiphile adrasta bandusia* Fruhstorfer

SPECIMENS: 3 ♂♂, 3 ♀♀; 1,100-2,300 feet; 29 June-30 Oct.

This species is uncommon and found only along the margins of the Semi-Evergreen Seasonal Forest. The butterflies usually rest on the undersurfaces of leaves with the wings held in a horizontal position and the heads downward and protruding just beyond the margins of the leaves. The flight is rapid and erratic.

167. *Epiphile plutonia* Bates

SPECIMENS: 5 ♂♂; 2.5 mi. NNW Ocotal Chico, 3,600 feet, 30 March 1965, 1 ♂; 3 mi. NNW Ocotal Chico, 4,100 feet, 30 July 1963, 1 ♂; 4,400 feet, 17 June 1963, 1 ♂; 4,800 feet, 16 July 1963, 2 ♂♂.

*Epiphile plutonia* is local, uncommon, and found only in the Montane Thicket on the upper slopes of Volcán Santa Marta. The butterflies were seen most frequently as they chased each other or as they rested on leaves (usually between ten and 20 feet above the ground) in patches of sunlight. The flight is very rapid and erratic. The present data are the only records of this species from Mexico. The nearest locale is the Polochic Valley of Guatemala (Godman & Salvin, 1879-1901).

168. *Catonephele nyctimus* (Westwood)

SPECIMENS: 13 ♂♂, 9 ♀♀; 700-3,750 feet; 9 Feb.-18 Oct.

This dimorphic species is uncommon to common and found in and along the margins of the Semi-Evergreen Seasonal Forest and Lower Montane Rain Forest. The males usually were seen along the margins of the forests whereas the females seemed to prefer the more shaded areas just within the forests. Both males and females fly within a few feet of the ground and usually within dense underbrush. The flight of the female is slower and weaker than that of the male and is very similar to that of



*Heliconius charitonius* (Heliconiinae) and female *Itaballia viardi* (Pieridae).

169. *Catonephele numilia esite* (Felder)

SPECIMENS: 4 ♂♂, 2 ♀♀; 1,100-2,700 feet; 7 May-1 Aug.

This dimorphic species is uncommon and found principally in the Lower Montane Rain Forest and the *Liquidambar-Quercus* Associates of the Montane Rain Forest. The butterflies seem to prefer less disturbed forests than do those of the related species *C. nyctimus*. The males usually were found along sunny trails within the forests (often visiting mule dung) whereas the females preferred the more shaded areas off the trails. The flight of the female is much slower and weaker than that of the male, which has a typical nymphalid flight.

170. *Nessaia aglaura* (Westwood & Hewitson)

SPECIMENS: 3 ♂♂, 4 ♀♀; 0-1,950 feet; 25 June-24 Sept.

*Nessaia aglaura* is uncommon in the Sierra; most specimens were collected in trap nets (using mangoes as bait) that were placed in the small patches of Semi-Evergreen Seasonal Forest bordering Lago Catemaco. The flight is characteristic of most members of the family.

171. *Myscelia cyaniris* Doubleday & Hewitson

SPECIMENS: 4 ♂♂, 8 ♀♀; 150-2,000 feet; 7 June-19 Sept.

This nymphalid is uncommon, seasonal, and local; most butterflies were collected in Pastures and the Semi-Evergreen Seasonal Forest in the vicinity of Lago Catemaco in August and September. The butterflies are attracted to sap oozing from trees.

172. *Myscelia rogenhoferi* Felder

SPECIMEN: 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 22 Sept. 1962.

This rare species was collected in a small patch of Semi-Evergreen Seasonal Forest bordering Lago Catemaco. The single female was resting on a small tree trunk when collected.

173. *Eunica monima* (Stoll)

SPECIMENS: 1 ♂, 3 ♀♀; 1,100, 1,800 feet; 6 June-2 Aug.

*E. monima* is uncommon and found only in Pastures. All butterflies were feeding on the blossoms of *Lantana camara* when collected.

174. *Eunica alcmena alcmena* Doubleday & Hewitson

SPECIMENS: 4 ♂♂; 1,900-2,600 feet; 16 June-12 July.

This *Eunica* is uncommon and found only in the Deciduous Woodland. All four butterflies were collected as they rested on living oak leaves and dead leaves on the ground. The flight is very rapid and erratic.

175. *Catagramma lyca* Doubleday & Hewitson

SPECIMENS: 6 ♂♂, 9 ♀♀; 2.25 mi. SW Sontecomapan, 800 feet, 14 July 1962, 2 ♀♀; 2.5 mi. SW Sontecomapan, 800 feet, 16 July 1962, 2 ♀♀; 900 feet, 15 July 1962, 1 ♀; 3 mi. SW Sontecomapan, 900 feet, 17 July 1962, 4 ♂♂; 2.5 mi. NE Tapalapan, 1,500 feet, 31 Aug. 1962, 1 ♂; 5 mi. E Cuetzalapan, 2,450 feet, 18 Aug. 1962, 1 ♂, 1 ♀; 3 mi. NNW Ocotal Chico, 17 June 1963, 1 ♀; 3 July 1963, 1 ♀; 4,200 feet, 30 July 1963, 1 ♀.

This species is locally common and found principally in the Lower Montane Rain Forest. The butterflies were collected most frequently as they rested on the undersurfaces of leaves approximately seven to 12 feet above the ground along relatively wide forest trails. Usually more than one individual was seen at any one locale. The flight is extremely rapid, erratic, and never below five to six feet of the ground. *C. lyca* has not been recorded previously from Veracruz. The nearest recorded locale is Tabasco (Hoffmann, 1940).

176. *Catagramma titania* Salvin

SPECIMENS: 6 ♂♂; 1,100 feet; 25 July-16 Oct.

This nymphalid is uncommon and found only in Pastures and along the margins of the Semi-Evergreen Seasonal Forest in the Catemaco Basin. The flight is very fast and erratic and usually slightly lower than that of *C. lyca*.

177. *Catagramma casta* Salvin

SPECIMEN: 1 ♀; 4 mi. NE Ocotal Grande, 1,200 feet, 9 June 1965.

This species is rare; the single female was collected along a sunny trail within the Lower Montane Rain Forest near the small village of Encinal. Several other specimens were seen at the same locale; these were darting from tree to tree between 15 and 30 feet above the ground. Thus, of the three species of *Catagramma* collected, *C. casta* seems to be the most uncommon and the most inaccessible.

178. *Diaethria anna* (Guérin)

SPECIMENS: 7 ♂♂, 12 ♀♀; 0-3,400 feet; 15 June-30 Oct.

Although common, the species is fairly local. Most butterflies were collected as they rested on leaves approximately three to five feet above the ground along the margins of the Lower Montane Rain Forest and the Semi-Evergreen Seasonal Forest. The butterflies are attracted to moist soil. The flight is very rapid and erratic.

179. *Diaethria astala* (Guérin)

SPECIMENS: 5 ♂♂; 1,100, 2,450 feet; 3 Aug.-15 Oct.

This species is uncommon, being found principally in Pastures and along the margins of the Semi-Evergreen Seasonal Forest. The butterflies seem to prefer less forested areas than does *D. anna*. The flight is similar to that of *D. anna*.

180. *Dynamine mylitta* (Cramer)

SPECIMENS: 15 ♂♂, 16 ♀♀; 500-2,700 feet; 20 May-14 Sept.

This dimorphic species is abundant in most open, sunny areas regardless of plant formation (except the Montane Rain Forest, Montane Thicket, and Elfin Woodland). The butterflies visit mud puddles very frequently. The flight usually is of moderate velocity and usually within two feet of the ground.

181. *Dynamine dyonis* Geyer

SPECIMENS: 3 ♂♂, 10 ♀♀; 1,625-2,550 feet; 23 March-28 Oct.

*D. dyonis* is much less abundant and more local in distribution than the preceding species, being found principally along the margins of the Lower Montane Rain Forest and the Semi-Evergreen Seasonal Forest. The flight is similar to that of *D. mylitta*.

## TRIBE Ageroniidi

182. *Hamadryas februa gudula* (Fruhstorfer)

SPECIMENS: 12 ♂♂, 6 ♀♀; 0-2,000 feet; 5 Feb.-23 Oct.

*H. februa gudula* is common to abundant throughout most of the Sierra, being found most frequently in Pastures and along the margins of all forests. This species (as well as the other five members of the genus) spend most of their time resting on the trunks and limbs of lichen-encrusted trees (particularly *Inga spuria*) or feeding on fermenting sap oozing from the injured trunks of citrus trees. The butterflies rest head downward and hold their wings in a horizontal position usually flat against the substrate. When changing positions, the butterflies walk with the wings constantly held in the horizontal plane. This resting behavior coupled with the wing coloration render the butterflies very inconspicuous. The butterflies are very "aggressive" and when anyone or any relatively large animal passes near a "perched" butterfly, it usually darts at the moving object making a characteristic clicking noise that can be discerned for distances as great as 50 to 100 feet away. After pursuing the moving object for a few seconds, the butterfly usually returns to the same tree or another nearby. As reported in Ross (1963), territoriality was

not demonstratable in this group—at least not for *H. februa gudula* and *H. g. guatemalena*.

183. *Hamadryas feronia farinulenta* (Fruhstorfer)

SPECIMENS: 6 ♂♂, 5 ♀♀; 1,100-2,400 feet; 5 Feb.-23 Oct.

This species is common only in the Deciduous Woodland and the *Pinus-Quercus* Associates. See comments under *H. februa gudula* listing for description of behavior.

184. *Hamadryas guatemalena guatemalena* (Bates)

SPECIMENS: 7 ♂♂, 2 ♀♀; 2 mi. NE Catemaco, 1,100 feet, 20 June 1962, 1 ♂; 25 July 1962, 1 ♂; 26 July 1962, 1 ♂; 11 Aug. 1962, 1 ♂; 28 Aug. 1963, 1 ♀; 29 Aug. 1963 1 ♂ (LSUMZ); 11 Sept. 1962, 1 ♂; 12 Sept. 1962, 1 ♀; 3 Oct. 1962, 1 ♂.

Although abundant in Pastures in the vicinity of Lago Catemaco, *H. g. guatemalena* nonetheless is less common than *H. februa gudula*. In other sections of the range, the species is only common to uncommon. See comments under *H. februa gudula* listing for description of behavior. The species was recorded previously from Veracruz only from the "Sierra Madre Oriental" (Hoffmann, 1940).

185. *Hamadryas iphthime* (Bates)

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 12 Sept. 1962.

This single individual was collected as it fed on sap oozing from the trunk of a citrus tree in a pasture. However, because of the close similarity between this species and several others in the genus, the possibility exists that I overlooked other individuals; thus the species may not be as rare as the data indicate.

186. *Hamadryas amphinome mexicana* (Lucas)

SPECIMENS: 7 ♂♂, 4 ♀♀; 1,100 feet; 20 June-3 Oct.

This species is uncommon but widely distributed throughout the range, being found principally in relatively open areas. The behavior is similar to that of other members of the genus.

187. *Hamadryas laodamia laodamia* (Cramer)

SPECIMENS: 1 ♂, 4 ♀♀; 1,100, 1,900 feet; 11 Aug.-7 Oct.

This *Hamadryas* is uncommon and found in Pastures. All butterflies were collected as they rested on the trunks of *Inga spuria*. The behavior is typical of other members of the genus.

188. *Marpesia chiron* (Fabricius)

SPECIMENS: 11 ♂♂, 5 ♀♀; 1,100-2,450 feet; 29 March-29 Oct.

The many banded dagger wing is abundant in most open, sunny areas and unrestricted to any plant formation; however, the butterflies are more common in the Deciduous Woodland

and the *Pinus-Quercus* Associes. During July 1963, a very large emigration of this species occurred on the Santa Marta massif (perhaps elsewhere, too). At that time hundreds and thousands of individuals were seen each day as they flew between eight and 20 feet of the ground in a northeasterly direction towards the coast. Occasionally several individuals would stop to visit mud puddles and the flowers of *Cordia spinescens*. The local inhabitants of the region informed me that this July emigration is an annual event and that it occurs in other parts of the Sierra as well as in the Ocotal region.

189. *Marpesia harmonia* (Klug)

SPECIMENS: 11 ♂♂; 5 ♀♀; 1,100-2,450 feet; 6 June-18 Sept.

This gold and silver species is locally common and found primarily around mud puddles (particularly on the grounds of the Catemaco Bottling Company—4.5 mi. NE Catemaco). However individuals also were netted frequently as they fed on the blossoms of *Cordia spinescens* and *Bidens pilosa* var. *bimucronata*. A sleeping assemblage consisting of approximately 15 butterflies (both males and females) was found at 9:00 A.M. on 6 June 1963 in a ravine within a *Bursera-Inga* community. The butterflies were resting on the undersurfaces of the leaves of *Cecropia mexicana*. I returned to the area several days later and periodically throughout the summer but never did I observe another congregation of butterflies. The flight of *M. harmonia* is relatively rapid, erratic, and usually between six and 15 feet of the ground.

190. *Marpesia corita* (Westwood)

SPECIMENS: 7 ♂♂, 3 ♀♀; 1,800-5,000 feet; 9 Feb.-18 Aug.

This *Marpesia* is locally common and found primarily along sunny trails in the Lower Montane Rain Forest, Montane Rain Forest and the *Liquidambar-Quercus* Associes. The butterflies fly very rapidly between one and two feet of the ground and pause frequently to alight on soil and rocks.

191. *Marpesia petreus* (Cramer)

SPECIMENS: 6 ♂♂, 4 ♀♀; 0-1,800 feet; 15 May-28 Aug.

The ruddy dagger wing is uncommon and found primarily along Hedgerows in the vicinity of Lago Catemaco. The butterflies were collected most frequently as they rested on leaves approximately three to six feet above the ground. The flight is rapid and erratic.

TRIBE Limnitiini



192. *Limenitis (Adelpha) melanthæ* (Bates)

SPECIMENS: 3 ♂♂, 2 ♀♀; 1,100-2,600 feet; 10 March-10 Nov.

This admiral is uncommon and local, most individuals being taken as they engaged in "hill topping" over a sunny knoll in the *Pinus-Quercus* Associates of the Deciduous Woodland. The flight is fast, erratic and usually above eight feet of the ground.

193. *Limenitis (Adelpha) leuceria* (Druce)

SPECIMENS: 11 ♂♂, 3 ♀♀; 2,100-5,400 feet; 24 March-4 Sept.

This species is common in the Montane Rain Forest, Montane Thicket, and Elfin Woodland. The butterflies usually were collected as they rested on leaves approximately six to 12 feet above the ground along relatively wide, sunny trails. The flight is very rapid, erratic, and usually in excess of six feet of the ground.

194. *Limenitis (Adelpha) erotia* (Hewitson)

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 2 Aug. 1962.

This species is rare; the single male was collected in a trap net (fermenting mangoes being used as bait) in a pasture bordering Lago Catemaco. *L. erotia* has not been recorded from Veracruz. The nearest recorded locales are "Sur y Oriente de Chiapas" (Hoffmann, 1940).

195. *Limenitis (Adelpha) oberthuri* (Boisduval)

SPECIMENS: 2 ♂♂; 3 mi. SW Sontecomapan, 1,600 feet, 1 Oct. 1962, 1 ♂; 5 mi. E Cuetzalapan, 2,450 feet, 17 Aug. 1962, 1 ♂.

This admiral is rare and found only in the Lower Montane Rain Forest. Both males were resting on leaves along sunny trails when collected. This species has not been recorded from Mexico. The nearest recorded locale is the Polochic Valley of Guatemala (Godman & Salvin, 1879-1901).

196. *Limenitis (Adelpha) iphicla* (Linnaeus)

SPECIMENS: 4 ♂♂, 10 ♀♀; 900-2,600 feet; 19 June-23 Oct.

*Limenitis iphicla* is common throughout most of the Sierra and is found along the margins of the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, and the Deciduous Woodland (including the *Pinus-Quercus* Associates). Within the oak and pine-oak communities, *L. iphicla* is the most common species of *Limenitis*. The flight is rapid, erratic, and usually between six and 12 feet of the ground.

197. *Limenitis (Adelpha) basiloides* (Bates)

SPECIMENS: 2 ♂♂, 2 ♀♀; 30-1,800 feet; 25 July-23 Oct.

This nymphalid is uncommon, being found along Hedgerows and the margins of the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest. All four specimens were collected as they rested on leaves approximately five to eight feet above the ground.

198. *Limenitis (Adelpha) felderi* (Boisduval)

SPECIMENS: 1 ♂, 1 ♀; 3.5 mi. SW Sontecomapan, 1,100 feet, 15 July 1962, 1 ♀; 1.25 mi. NE Ocotil Chico, 2,600 feet, 12 July 1963, 1 ♂.

This species is rare; the female was collected as it flew about three feet above the ground in a bamboo thicket in the Semi-Evergreen Seasonal Forest, and the male as it rested on a leaf in a partially shaded area of disturbed Lower Montane Rain Forest. Thus, it appears as if this species prefers more shaded and heavily forested areas than do most of the related species.

199. *Limenitis (Adelpha) sentia* (Godman & Salvin)

SPECIMENS: 2 ♀♀; 1.75 mi. E Sontecomapan, 0 feet, 6 Aug. 1962, 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 14 Sept. 1962, 1 ♀.

This species, like the preceding, is rare and seems to be restricted to Swamp Forest and Pasture plant formations. The flight is similar to that of most nymphalids. The nearest recorded locale is "Península de Yucatán" (Hoffmann, 1940).

200. *Limenitis (Adelpha) paraeca* (Bates)

SPECIMENS: 5 ♂♂, 11 ♀♀; 0-2,500 feet; 10 May-23 Oct.

This admiral is common to abundant and the most common and widespread species of *Limenitis* in the Sierra. The butterflies are numerous both along the margins of forests and thickets and in pastures. The behavior is similar to that of most other species in the genus.

## TRIBE Apaturidi

201. *Apatura cherubina* (Felder)

SPECIMEN: 1 ♀; 3 mi. WSW Santiago Tuxtla, 2,100 feet, 30 Aug. 1962.

This species is rare; the single female was collected as it rested on a leaf approximately five feet above the ground beside the dirt road ascending Cerro Tuxtla; the road is bordered by Semi-Evergreen Seasonal Forest.

202. *Apatura pavon* (Latreille)

SPECIMENS: 1 ♂, 2 ♀ ♀; 1,100 feet; 22-30 July.

*Apatura pavon* is uncommon and restricted to Pastures. All specimens were collected as they rested on the leaves of shrubs. Disturbed butterflies fly very rapidly but for only short distances (usually eight to 12 feet); they then alight on leaves.

203. *Apatura laure* (Drury)

SPECIMENS: 2 ♂ ♂, 1 ♀; 500, 1,100 feet; 30 June-22 Aug.

This *Apatura* is uncommon; one butterfly was collected as it rested on a paved highway, another as it was feeding on the flowers of *Cordia spinescens* in a pasture, and the third as it was flying rapidly about three feet above the ground in a pasture.

204. *Historis odius* (Fabricius)

SPECIMENS: 2 ♂ ♂, 3 ♀ ♀; 500-1,600 feet; 6 June-1 Oct.

This species is uncommon; most butterflies were collected as they fed on sap oozing from the trunks of citrus trees growing in Pastures in the vicinity of Lago Catemaco. The flight is extremely rapid with powerful wing beats, erratic, and usually in excess of six feet of the ground.

205. *Smyrna blomfildia datis* Fruhstorfer

SPECIMENS: 9 ♂ ♂, 6 ♀ ♀; 1,100 feet; 28 July-22 Sept.

Although common in the vicinity of Lago Catemaco, *S. blomfildia datis* is uncommon elsewhere. All butterflies were netted as they fed on sap oozing from citrus trees growing in Pastures. The flight is extremely rapid, erratic, and usually in excess of six feet of the ground.

206. *Gynaecia dirce* (Linnaeus)

SPECIMENS: 3 ♂ ♂, 8 ♀ ♀; 800-1,950 feet; 4 Feb.-24 Sept.

*Gynaecia dirce* is common only in the Catemaco Basin; most butterflies were collected either as they fed on sap oozing from citrus trees in Pastures or in trap nets in small sections of the Semi-Evergreen Seasonal Forest bordering Lago Catemaco. The flight is similar to that of most members of the family.

TRIBE Charaxidi

207. *Prepona demophon centralis* Fruhstorfer

SPECIMENS: 8 ♂ ♂, 1 ♀; 900, 1,100 feet; 9 July-1 Nov.

This species is locally common and found primarily in Pastures in the vicinity of Lago Catemaco. The butterflies were collected most frequently as they imbibed fermenting sap oozing from the trunks of citrus trees. The flight of this species (as well as that of the other four species in the genus) is extremely rapid with powerful wing beats, erratic, and usually between six and 15 feet of the ground.

208. *Prepona antimache gulina* Fruhstorfer

SPECIMENS: 5 ♂ ♂, 3 ♀ ♀; 900, 1,100 feet; 10 May-8 Oct.

This species is locally common and was collected under the same circumstances as *P. demophon centralis*.

209. *Prepona amphimachus* (Fabricius)

SPECIMENS: 5 ♂ ♂, 3 ♀ ♀; 1,100 feet; 27 July-2 Nov.

This *prepona* is locally common and restricted to Pastures in the Catemaco Basin.

210. *Prepona laertes pallantias* Fruhstorfer

SPECIMENS: 2 ♀ ♀; 2 mi. NE Catemaco, 1,100 feet, 14 Sept. 1962, 1 ♀; 3 Oct. 1962, 1 ♀.

This nymphalid is rare; both females were collected as they imbibed fermenting sap oozing from citrus tree trunks in Pastures.

211. *Prepona brooksiana* Godman & Salvin

SPECIMEN: 1 ♀; 4 mi. N Ocotil Chico, 4,100 feet, 3 Aug. 1963.

This large *Prepona* is rare; the single female was collected in the Montane Thicket on Volcán Santa Marta. It was flying relatively slowly around several small trees as if searching for a suitable site on which to oviposit. Another individual was seen in the same type forest on Volcán San Martín Tuxtla on 26 August 1962. The species is recorded from Veracruz only from Coatepec (Hoffmann, 1940).

212. *Anaea (Siderone) marthesia* (Cramer)

SPECIMENS: 2 ♀ ♀; 2 mi. NE Catemaco, 1,100 feet, 22 July 1962, 1 ♀; 5 Nov. 1962, 1 ♀.

This brilliantly colored leaf wing is rare; one butterfly was collected as it flew approximately six feet above the ground through a pasture and another as it fed on fermenting sap oozing from a citrus tree growing in a pasture. The flight is very rapid and erratic. At rest, individuals (of this species as well as all other species in the genus) usually hold their wings in a vertical position so that a distinct break or notch is formed between the two pairs of wings. This behavior enhances the camouflage created by the ventral wing coloration by producing the illusion of a partially frayed leaf.

213. *Anaea (Zaretis) itys* (Cramer)

SPECIMENS: 2 ♂ ♂, 7 ♀ ♀; 1,100 feet; 9 Aug.-6 Oct.

This species is locally common and seasonal. Butterflies were collected in two habitats—Pastures and along Hedgerows in the

## NOTICES

**DEFECTIVE COPIES:** Some missing pages have been detected in volume 14, number 4. Please check your copy; correct copies will be sent to those who received faulty issues and indicate such to us.

**ADDRESS CORRECTION:** Kurt Johnson, author of "Post Pleistocene Environments and Montane Butterfly Relicts on the Western Great Plains" in volume 14, number 4 of the Journal: Dept. of Biology, City University of New York, City College, Convent Ave. and 138th Street, New York, NY 10031.

**PUBLICATIONS:** Moths of Southern Africa. E. C. G. Pinhey, Tafelberg Publishers Ltd., 28 Wale St., Cape Town, South Africa. Available in U. S. A. from Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, CA 90007. \$35.95.

Butterflies of West Malaysia and Singapore, Vol. 1 and 2, W. A. Fleming, E. W. Classey Limited, Park Road, Faringdon, Berkshire, England. Available in U. S. A. from E. R. S. (above). \$47.00 set.

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# THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

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NOTE ON THE CHROMOSOMES OF  
*BYBLIA ILITHYIA* (DRURY)  
(NYMPHALIDAE)

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ABSTRACT

Haploid chromosome number of the nymphalid butterfly *Byblia ilithyia* is 17. This forms the second report in the genus *Byblia*. Attempt is also made to study meiotic details like chiasma frequency and terminalization coefficient based on metaphase I configurations.

THE GENUS *Byblia* IS REPRESENTED IN INDIA by only one species viz. *B. ilithyia* (Drury) which is confined to peninsular region (Wynter-Blyth 1957). Although the chromosome numbers of considerable number of nymphalid butterflies are on record, there is no cytological work on *B. ilithyia*. The present communication, which forms the second report in the genus *Byblia* deals with the chromosome number and also some meiotic details like terminalization coefficient and chiasma frequency based on metaphase I stages.

MATERIAL AND METHODS

The material for study was collected from the fields around A.U. Postgraduate Centre, Nallapadu, Guntur. Testes of adults were squashed in 2% Acetic orcein without prefixation. The preparations were made permanent following the quick freeze method. Counts were made on well-spread metaphase plates. Photographs were taken and camera lucida figures were drawn using X 100 oil immersion lens.

OBSERVATIONS

Metaphase I plates show clearly 17 bivalents with little size variation (Fig. I). Most of the bivalents were dumb-bell shaped with single terminal chiasma; however, cross bivalents with single interstitial chiasma and rings with two terminal chiasmata were also occasionally observed. Precociously separated univalents, which assume the shape of a rod, were also detected sometimes in Metaphase I.

Mitotic plates (Fig. II) show 34 spherical, almost isodiametric bodies which further confirm the haploid number as 17.

### DISCUSSION

De Lesse (1968) reported the haploid chromosome number of *B. acheloia* as 26. The finding of  $n = 17$  in a closely related species like *B. ilithya* underlines the importance of the role of fusions and fragmentations in the speciation of lepidopterous insects, whose chromosomes are of a holokinetic nature. The chromosome number of *B. ilithya* deviates remarkably from the modal number ( $n = 31$ ) of the order Lepidoptera and also of the family Nymphalidae (Soumalainen 1969, Ray Robinson 1971).

Soumalainen (1953) opined that in majority of Lepidoptera the bivalents in the diakinesis of spermatogenesis are ring shaped, whereas in oogenesis the bivalents have only one terminal chiasma. But, in *B. ilithya* by the time spermatocytes reach late diakinesis and early metaphase most of the bivalents assume dumb-bell shape with a terminal chiasma and also the frequency of ring bivalents is very low.

Though the large number, small size and typical spherical form of lepidopteran chromosomes frustrate the observation of their structure and behaviour, an attempt is made to calculate terminalization coefficient and chiasma frequency. Out of 2975 bivalents in 175 nuclei studied in 10 specimens, 162 were cross bivalents, 64 were ring bivalents, 2556 were dumb-bell shaped with only a terminal chiasma and 193 separated early into distinct univalents. The terminalization coefficient ranges from .806 to .960 with a mean of .916 and the chiasma frequency ranges from .823 to .994 with a mean of .922.

Like in *Bombyx mori* L (Maeda, 1939) for which extensive genetic data are available, in *Byblia ilithya* also, the low genetic recombination is compensated by the large number of chromosomes, which in general seems to be valid for the entire order itself.

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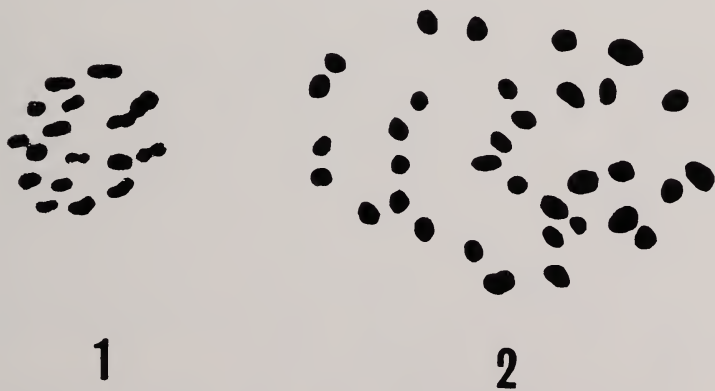


Fig. I.—Metaphase I stage of *B. ilithyia*  
Fig. II.—Mitotic metaphase stage of *B. ilithyia*

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## FOSSIL BUTTERFLIES AND THE EVOLUTION OF LEPIDOPTERA OAKLEY SHIELDS

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### ABSTRACT

The meager Cenozoic fossil record of butterflies is traced. Although pre-Tertiary fossils are so far lacking, their development likely paralleled that of their angiosperm foodplants which probably arose in Early Mesozoic or Late Paleozoic times. The geological and morphological evidence herein suggests that primitive moths originated in the Permian, with primitive butterflies evolving from the Castnioid line soon thereafter, sometime in the Triassic. The major radiation of Lepidopteran families was already completed by the Upper Jurassic-Early Cretaceous when continental drift began, judging by their present-day, world-wide distribution.

### INTRODUCTION

FOSSIL BUTTERFLIES ARE GREAT RARITIES, though moth fossils are more abundant. Butterflies' frail bodies and powers of flight may explain why they are rarely fossilized (Fox, 1948). Of 15,000 insect fossils from the Florissant beds of Colorado examined by Scudder (1889a), only 8 were butterflies. In all, about 41 specimens are known to science, many discovered about a century ago; all known occurrences derive from Cenozoic deposits (Table 1). Scudder's papers on fossil butterflies (1875, 1889b) are classics; he was without a doubt the most solid authority in this field. His interpretation of the affinity of *Apanthesis leuce*, however, was in error (Comstock, 1961).

The purpose of this paper is to review the scattered literature of the fossil record for butterflies and to determine at what evolutionary stage and geologic time interval the butterfly-moth lines diverged.

### CENOZOIC BUTTERFLIES

By the lower Oligocene, the subfamilies Hesperinae, Satyrinae, Parnassinae, Coliadinae, Pierinae, Libytheinae, and Nymphalinae (plus an unplaced lycaenid) were present, signifying that all the major families of butterflies had developed by that time (Table 1). According to Zeuner (1962), "The Oligocene and Miocene species are very closely related to existing forms,

and are in no way more primitive," an opinion shared by Comstock (1961).

I concur with Wangrin (1939) that the fossil in an Oligocene nodule from Szczecin (= Stettin), Poland, is a butterfly with the head, body, and (two?) wings preserved, after viewing the figure (a pierid?). This locality was a seacoast, as many mollusks, some fish, a seacow, crabs, and a single bryozoan are known (Wangrin, 1939), and it is currently near the coast. No other insects are known. Similarly the two Gabbro, Italy, butterflies are from a seacoast locality. These Upper Miocene deposits are limestones containing calcareous algae, foraminifera, corals, and mollusks, with intercalations of pebbles not uncommonly, and rarely sands and clays (Desio, 1973, p. 590).

For butterflies, the richest fossil deposits are located at Florissant, Colorado. These are lacustrine beds with abundant plant and insect remains dated from the upper part of the Lower Oligocene, deduced from its relationship with other fossil floras, fossil vertebrates, and lithologic correlation (MacGinitie, 1953). The climate at that time was subhumid and warm temperate. Its butterfly fauna displays affinities to the Neotropics (Scudder, 1889a), although the two libytheids (I have examined the fossil *Prolibythea* and the description of *Barbarothea*) are related to living species from southeastern Asia and the Indo-Australian regions, respectively. The butterflies from the calcareous marls of the gypsum quarries of Aix-en-Provence, France, mostly show Indo-Malayan affinities, while the two hesperiids from Aix and Rott display a relationship to subtropical North American genera (Scudder, 1875, 1889a). Saporta (1872) notes that the fossil angiosperm flora of Aix is related on the generic level primarily to southeastern Asia (see also Scudder, 1875, pp. 79-80). Two of the Radoboj butterflies from Yugoslavia display a "subtropical temperate American" affinity while the third, *Myllothrites pluto*, is African (Scudder, 1875).

Conditions apparently favorable for the preservation of butterfly wings include the margins of lakes, rivers, streams, and seacoasts, particularly during the Lower Oligocene and Miocene. In Oligocene-Miocene times, clay, sand, silt, mud, shale, limestone, marls, volcanic ash and dust, lacustrine, and freshwater deposits are common. This was a period of range erosion, basin fill, volcanic outpourings, and faulting, with plentiful fossils of mammals, plants, insects, soft-bodied invertebrates, etc.

The head capsule of a microlepidopteran larva in Canadian amber of the Cretaceous period is widely believed to be the

first evidence of Lepidoptera before the Tertiary (see MacKay, 1970). Recently some lepidopteran scales of a probable Micropterygidae were discovered in amber from the lowermost Upper Cretaceous (Cenomanian) of northwestern France (Kühne, Kubig, & Schlüter, 1973; Schlüter, 1975).

### LEPIDOPTERA EVOLUTION

The present-day distribution of related butterflies in tropical regions on separated continents suggests that their radiation occurred prior to continental drift and seafloor spreading, i.e. before Upper Jurassic-Early Cretaceous times. For example, the Morphinae-Amathusiinae and Ithomiinae are confined to the Neotropics and Indo-Australian regions and are absent from Africa. The Riodininae are worldwide but with their greatest development in the Indo-Australian and Neotropical regions. The Neotropical Heliconiinae (2 genera) is closely paralleled by the Oriental *Cethosia* (Clark, 1927). The Pyrginae genus *Celaenorrhinus* occurs in tropical America, Asia, and the Orient (Evans, 1949). Neotropical-African links occur in the Acraeinae and Charaxinae. The Eunicini, a large tribe of Nymphalidae, is confined to South America except for *Asterope* from Africa (Carcasson, 1964, p. 152). *Hypanartia* is developed in tropical America, Africa and one or two species on Mauritius and neighbouring islands; *H. delius* from West Africa closely resembles certain American species (Eliot, 1947).

The Lepidoptera likely arose in a symbiosis (i.e. coevolved) with the first flowers (Forbes, 1932; Wangrin, 1939; Comstock, 1961; Eaton, 1963; Owen, 1971, p. 148; Common, 1975), as most modern species use angiosperms for larval food and adult nectar. Lepidoptera and Trichoptera arose from a common ancestor; the latter date back to the Permian (Ross, 1967). According to Kristensen (1975, pp. 32-33), Trichoptera and Lepidoptera share numerous biological characteristics that place them in the same monophyletic superorder (Amphiesmenoptera), but that Lepidoptera did not evolve from Trichoptera because their larvae differ in certain fundamental characters. No angiosperms are supposedly known before the Early Cretaceous, and there is a lack of fossil evidence regarding ancestral forms; "the evolutionary advancement and diversity commonly attributed to Early Cretaceous representatives of the angiosperms has been interpreted to imply either (1) their relatively rapid evolution in middle Mesozoic time, or (2) their extended pre-Cretaceous

existence" (Scott, Barghoorn, & Leopold, 1960). Axelrod (1961, 1970) marshalls evidence for angiosperms originating in moist tropical upland (but not highland) regions during Permo-Triassic time, long before they began to invade the lowland sites of deposition in the Early Cretaceous, as indicated by many primitive living angiosperms persisting in upland sites. He notes that the extraordinary rate of evolution demanded of the vegetative plant body by a middle Mesozoic origin is highly improbable. Croizat (1968) thinks angiosperms originated soon after the Permo-Carboniferous glaciers had destroyed the Paleozoic flora. Hawkes & Smith (1965) reason that angiosperms originated in Permian (or Carboniferous) times in Gondwanaland before the onset of continental drift. Indeed, Radforth & Rouse (1956) report references to a tricolpate pollen in a Jurassic sediment and tetra-porate pollen resembling *Alnus* (Betulaceae) from Mississippian strata of Russia.

Butterflies no doubt originated from a moth line that was the common ancestor of the Cossidae and Castniidae (Forbes, 1960, p. 58) or directly from Castnioid stock (Brock, 1971). Miller (1970) emphasizes that Hesperioidea are morphologically closely allied to the Castniidae. One Pyrginae, *Euschemon*, still retains the frenulum and retinaculum of moths (Turner, 1947, p. 316). The most primitive moths are the Homoneura consisting of the Micropterygoidea and the Hepialoidea; the most primitive family is the Micropterygidae, with biting mouth-parts and neuration similar to the most primitive family of Trichoptera, the Rhyacophilidae, and to the Upper Permian *Belmontia* of Paramecoptera from the Upper Coal-Measures of Newcastle, N. S. W. (allied to Mecoptera and Protomecoptera) that Tillyard believes from his detailed analysis to be the common ancestor of the Trichoptera and Lepidoptera (Tillyard, 1919; Turner, 1947). Friese (1970) thinks Hepialoidea rather than Micropterygoidea should be regarded as the most primitive lepidopteran group, based on a number of previously neglected characteristics interpreted according to Hennig's phylogenetic rules. Turner (1947, p. 313) postulates a hypothetical family Proto-cossidae to link Cossidae-Tineidae remotely with the stem from which Micropterygoidea and Hepialoidea arose. Nisulescu (1970) has discovered rudimentary mandibles in *Castnia daedalus*, so perhaps Castniidae itself is close to the Micropterygoidea line. Tindale (1963) has proposed that butterflies should be regarded as a subordinal group (Schizoneura) approximately



equal in importance to the rest of the Heteroneura and separate also from the Homoneura, based on a deep division between the forewing vein stems ( $R_2 + R_3$ ) and ( $R_4 + R_5$ ) in early pupal stages in the higher families of butterflies and *Euschemon*. Thus butterfly radiation probably occurred near the beginning of moth evolution, perhaps sometime in the Triassic, filling the diurnal niche along with primitive day-flying moths like the Castniidae.

From Upper Permian to Middle Triassic, arid or semi-arid climates were widespread (Kummel, 1970). The larvae of Hepialidae, Cossidae, and Castniidae feed within stems and roots (or externally on roots in the soil), perhaps originally as a response to increasing aridity (Common, 1970, p. 782). Likewise the Megathymidae, an archaic butterfly family formerly placed in the Castniidae, burrow as larvae into the basal leaves and roots of Agavaceae to feed in arid regions. The radiation of the primitive Lepidopteran families seems to fit an earth-expansion model in which the continents on the east and west sides of the Pacific were joined in a continuous landmass prior to the Upper Jurassic (Shields, 1975). I.e., Micropterygidae has an extremely wide distribution but with its headquarters in New Zealand, Hepialidae genera are greatest developed in Australia and the Neotropics (Paelt, 1953), Castniidae has its stronghold in the Neotropics, and Megathymidae is confined to southern North America and Central America (Eriocraniidae and Cossidae are generally distributed).

According to Davis (1975), the primitive family Neopseustidae resembles the Hepialoidea and Nepticuloidea in certain characters and is confined to southeast Asia and Chile.

Although some transoceanic movement following continental breakup did occur, it appears unlikely that any massive post-drift dispersal of the major butterfly groups took place between the tropical regions, since the intervening islands show no evidence of this and the Bering land bridge was never tropical. In the Pacific, small islands lying near continents such as the Galapagos, Samoa, Fiji, Carolines, and Guam are populated by a fair number of butterfly species compared with more distant islands like Napuka, Funafuti, Bikini, Rapa, Fanning, Canton, Gilberts, Wake, Necker, and Marquesas which are each composed of three (or less) migrant species. A similar pattern pertains to the Atlantic and Indian Oceans.

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TABLE 1. The known fossil record for butterflies.<sup>1</sup>

Horizon	Locality	Deposit	Families	References
Upper Eocene or Lower Oligocene	?	Baltic amber	1 lycaenid (larva)	Handlirsch, 1906-1908
Upper Eocene or Lower Oligocene	?	Baltic amber	2 (?) papilionids	Larsen, 1974, p. 34
Lower Oligocene	Florissant, Colorado	lacustrine beds	2 pierids, 2 libytheids, 7 nymphalids	Scudder, 1891; Cockerell, 1907, 1913; Handlirsch, 1906-1908; Brown, 1976
Lower Oligocene	Aix-en- Provence, France	calcareous marls of gypsum quarries	1 hesperiid, 1 papilionid, 1 pierid, 3 satyrids, 1 lycaenid	Scudder, 1891; Handlirsch, 1906-1908; Theobald, 1937



Lower Oligocene (Lattorfian)	Gurnet Bay, Isle of Wight	Osborne and Headdon Beds of freshwater sands, clays, limestones	1 nymphalid	Zeuner, 1962
Middle Oligocene	Stolzenhagen near Szczecin, Poland	concretionary nodule of cemented marine sand	1 unplaced adult	Wangrin, 1939
Upper Oligocene	Rott, Rhine basin, Bavaria, Germany	lignite beds	1 hesperiid	Scudder, 1891; Handlirsch, 1906-1908
Lower Miocene	Radoboj, Yugoslavia	marls of lacustrine beds	1 pierid, 2 nymphalids	Scudder, 1891; Handlirsch, 1906-1908; Zeuner, 1942

TABLE 1. (continued).

Horizon	Locality	Deposit	Families	References
Middle Miocene (Karagan)	Stavropol, North Caucasus	continental deposits; "fragile rocks alternate with gray sandy clays"	2 nymphalids	Nekrutenko, 1965
Upper Miocene (Tortonian or Lower Messinian)	Gabbro, Italy (S. of Livorno, on the coast)	seacoast limestones	1 lycaenid, 1 papilionid	Handlirsch, 1906-1908
Upper Miocene (Sarmatian)	Randecker Maar, SW Germany	extremely fine shale called dysodil or paper-coal	1 pierid	Zeuner, 1942

Pleistocene	Shiobara, Japan	lake deposits	1 papilionid	Fujiyama, 1968
Pleistocene	?	?	2 hesperiids, 1 nymphalid	Zeuner, 1962
Pleistocene or Recent	East Africa	amber	1 pierid	Zeuner, 1942
Quaternary	Re, Italy	lacustrine beds	1 lycaenid, 1 unplaced pupa	Handlirsch, 1906-1908
Recent (2000-3000 years)	Lindi and Bagamoyo, Tanzania	amber	1 nymphalid, 1 unplaceable adult	Evers, 1907

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- <sup>1</sup> Leahey (1953) found undetermined Lepidoptera larvae and pupae in Miocene sandstone and clay beds from Rusinga and Mwafangano islands in Lake Victoria, Kenya.

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## ABERRANT SPECIES OF NEW JERSEY LEPIDOPTERA

JOSEPH MULLER

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All specimens are somewhat enlarged.

Explanation of figure:

Top row: The first two aberrant *Satyrium acadica acadica* (Edwards) were caught by the author in northern New Jersey near Colesville on July 9, 1965. Both males differ from normal because the markings on the underside of the secondaries are cream white instead of orange. The third male was collected by F. Rutkowski at the same place on July 8, 1966, with the aberrant markings yellow. Spots on top of secondaries are much reduced and are pale yellow.

Second row: The first specimen, *Satyrium calanus falacer* ab. "heathii" (Fletcher) was collected by F. Rutkowski on milkweed at Lakehurst, N.J. on July 4, 1967. The second specimen is an aberration of *S. c. falacer* (Godart) also collected at Lakehurst by F. Rutkowski on June 29, 1968. The third specimen is a small aberration of *Callophrys hesseli* (Rawson & Ziegler) of the second brood, collected at Lakehurst, N.J. on Aug. 2, 1951.

Third row: This large specimen of *Catocala praeclara* Grote & Robinson emerged on June 15, 1962. Its parent had been caught in northern New Jersey. When fresh, the specimen figured was almost all green. It measures 4.8 cm. while all the other *C. praeclara* in my collection measure 4.1 cm. Never having been able to rear *C. praeclara* or *Crataegus* (given as the food plant by Mayfield in Forbes 1954, p. 336), I was able to rear this specimen on wild cherry. It was the only one as all the other larvae died. Though I don't believe that wild cherry is the right food plant for this insect, it is amazing that only one larva produced such a large adult.

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## AN AREA CENSUS METHOD FOR ESTIMATING BUTTERFLY POPULATION NUMBERS. PER DOUWES

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### INTRODUCTION

KNOWLEDGE ABOUT POPULATION SIZE (or density) is often desirable in ecological and other studies in butterflies. Usually population numbers are estimated from capture-recapture data. Using this method it is possible to obtain accurate estimates of population size and also of birth and death rate. However, to obtain good estimates it is often necessary to capture and mark a large number of individuals which is a time-consuming task. Moreover the individuals captured may become disturbed resulting in unnormal movements and distribution patterns.

To avoid these drawbacks I proposed an area census method which is a line transect where the line covers the whole area inhabited by the butterfly population (Douwes, 1970). This method implies that all individuals observed are counted and that searching is carried out in the same manner in the whole area. In a population study of *Heodes virgaureae* (Lycaenidae) area censuses were compared with capture-recapture estimates and a high correlation between the two kinds of estimates was found provided that weather conditions were favorable when the censuses were carried out (Douwes, 1970). This promising result initiated further investigations to see if the area census method can be used for other species and by other investigators.

To test this, the size of two *Clossiana selene* populations (Nymphalidae) were estimated by three different persons using the area census method and the figures so obtained were checked against absolute estimates from capture-recapture data.

### MATERIAL AND METHODS

Investigations were carried out in two areas E of Lund, southern Sweden, in 1969 and 1970. Each area consisted of meadow on dry to wet ground with *C. selene* concentrated to the wet parts. Both areas seemed to be isolated from other areas

suitable for *C. selene*. The area studied in 1969 was 50 m by 100 m; the area studied in 1970 was smaller and more irregularly shaped (Fig. 1).

Censuses were made on 7 (1969) and 16 (1970) occasions, each time by three observers (PD, GN and AO) all walking the same route (at a speed of approximately 1 m/sec.) that zigzagged through the area. The distance between a zig and the following zag was approximately 10 m. The situation in 1970 is shown in Fig. 1. To make things as equal as possible the three observers censused near each other in time, the first observer starting 2 min. before the second one, etc. Also the sequence of the observers was continually changed so that each started first, in the middle, and last the same number of times (not exactly, since 23 occasions is not exactly divisible by 3). The total population was estimated from capture-recapture data and the following procedure was followed. All three investigators moved together from one end of the area to the other and all *C. selene* encountered were caught, marked (if not already marked) and immediately released again. A felt-tipped dye pen was used for marking and each specimen was given an individual number on the ventral surface of the hindwing. Thus when recaptured the number had to be recorded only and no further marking was necessary. From the data so obtained population size with standard error was calculated by the method of Jolly (1965).

## RESULTS

The numbers observed in the censuses and the absolute estimates are given in Table 1. There is a fairly high correlation between numbers censused and absolute estimates (Fig. 2), and also between the numbers observed by the different investigators the correlation coefficient being 0.88 between PD and GN, 0.82 between PD and AO, and 0.84 between GN and AO. The standard errors being only 6 to 19 per cent of the total estimates show that errors of estimates are small (Tab. 1). Thus assuming the conditions underlying the model are fulfilled, i.e. random sampling, a comparison of numbers censused with absolute estimates yields a reliable picture of the variation in the proportion observed in the censuses (within and between observers). The correlation coefficients mentioned above (Fig. 2) suggest that each of the observers censused a fairly constant proportion of the population. From the regressions in Fig. 2 it is obvious that there is a good agreement between the censuses



Fig. 1.—The investigation area in 1970 showing the route followed when the area censuses were made. Individuals observed along the parts of the route indicated by a broken line were not counted.

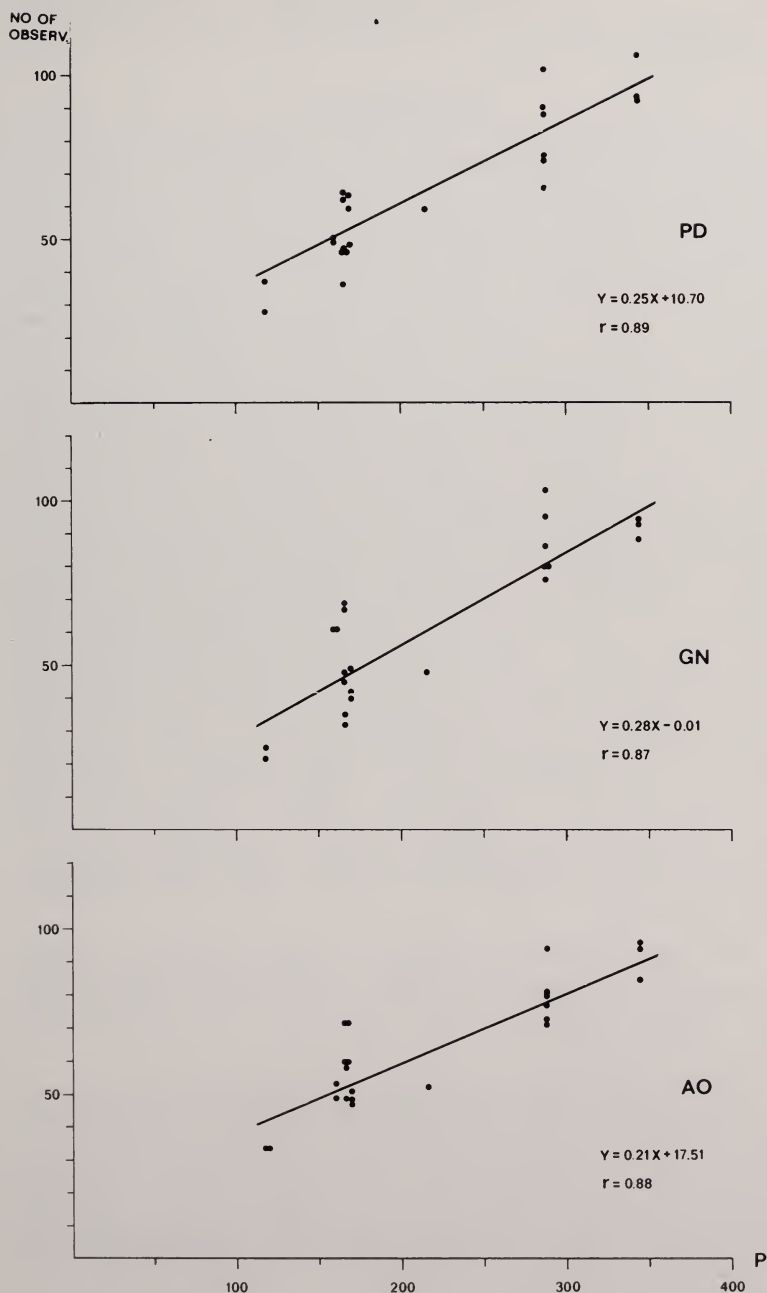


Fig. 2.—The number of observations of *C. selene* (area censuses) plotted against population size (P). Area censuses were made by three different persons PD, GN, and AO.

of the three observers all observing about 30 per cent of the population.

### DISCUSSION

So far the area census method has been tested on two butterfly species and in both cases reliable estimates were obtained. Moreover the proportion observed turned out to be about 30 per cent in both *H. virgaureae* and *C. selene*. As to the former species the absolute estimates were erroneously regressed on the numbers censused (Douwes, 1970). Therefore, the correct diagram is given here (Fig. 3). Due to the high correlation between numbers observed and absolute estimates the conclusion previously drawn, i.e. that about one third of the population was observed, still holds. Common to *H. virgaureae* and *C. selene* is that they are rather sedentary and easily observed, two facts that make these species particularly suitable for censusing. The larger the proportion seen the less the variation in the estimate of the population size is. Censuses of more active species are probably less reliable because of multiple observations of individuals. A necessary prerequisite for this census method is that the species studied can be identified in the field. This is true for *H. virgaureae* and *C. selene* although the latter may occasionally occur together with other small fritillaries. In this study we observed a few worn and pale *C. euphrosyne* in the beginning of the investigation period in 1970 and at the end of the investigation in 1969 some *Brenthis ino* appeared which were somewhat larger and distinctly brighter than the no longer fresh *C. selene*. I believe that a trained observer is able to recognize most butterfly species in the field at least in northern Europe. Exceptions are *Pieris* spp., large fritillaries, and most blues.

Not tested here but certainly of great importance for the outcome of the census is the length of the census route per unit area. In this study the route length was 1.3 - 1.5 km/hectare (0.3 - 0.4 miles/acre).

The censuses of the three observers yielded very similar estimates indicating that inter-observer variation is insignificant provided that the censuses are made by trained butterfly observers which was the case in this study. However, the high degree of similarity in census results might to some extent be explained by a slight interdependence; the different observers walked exactly the same route and they may have adopted an unusually similar searching behavior.



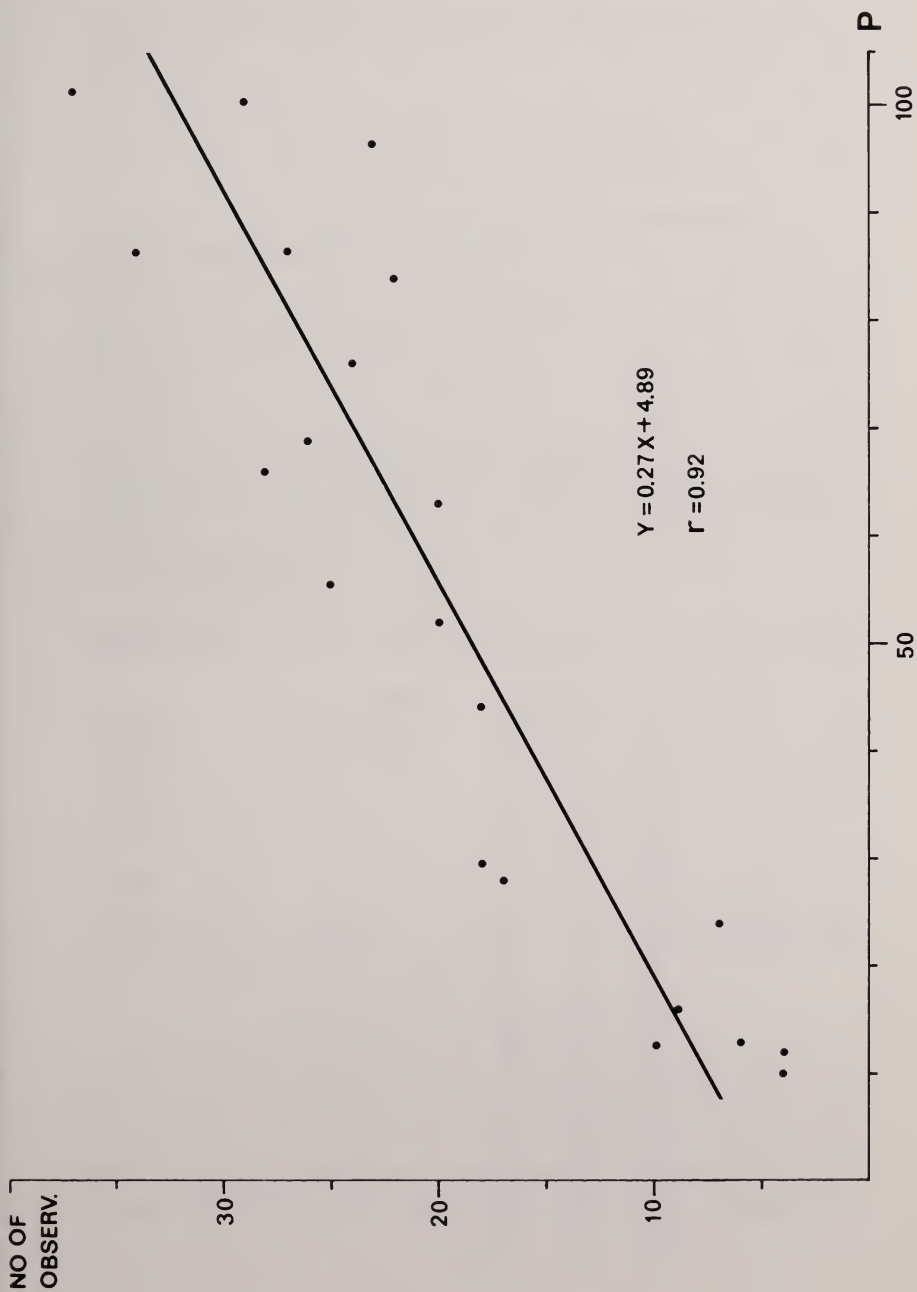


Fig. 3—The number of observations of *Heodes virgaureae* (area censuses)

The time saved by the area census method as compared to capture-recapture is quite significant. For instance, for the population studied in 1970 a census took about 25 min., whereas for capture, mark, and release we used 2-3 man hours each time. Moreover to estimate the population size on  $x$  occasions,  $x$  censuses are needed but the butterflies have to be captured on  $x+2$  occasions in a capture-recapture study.

In summary, the area census method seems to give sufficiently accurate estimates of population size in suitable species such as *H. virgaureae* and *C. selene*. Different census estimates made by one and the same person can be directly compared and possibly also censuses of different observers but this has to be tested further. I hope this paper will stimulate to further research in this field.

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Table 1. Area censuses by three different observers (PD, GN, and AO) and absolute estimates of two populations of *Clossiana selene* in 1969 (population 1) and 1970 (population 2).

year	date	area censuses			absolute estimates (capture-recapture) total popul.	standard error
		no. of observations	PD	GN	AO	
1969	26.6	49	61	53	161	24.7
		50	61	49		
	27.6	59	42	49	170	32.6
		63	49	51		
		48	40	47		
	3.7	37	22	34	119	20.9
1970	15.6	28	25	34		
		69	48	52	216	28.2
	16.6	57	45	49	167	13.7
		62	69	60		
		56	34	72		
		56	67	72		
		64	48	58		
	18.6	36	32	60		
		65	76	73	288	22.8
		75	80	71		
	19.6	88	80	77		
		74	86	94	288	23.6
		90	95	81		
		102	103	80		
	22.6	92	93	96	345	21.6
		106	88	94		
		93	94	85		

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## DIGESTIVE ENZYMES OF SUGARCANE PINK BORER,

SESAMIA INFERENS WALKER (LEPIDOPTERA)  
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### ABSTRACT

In the salivary glands of *Sesamia inferens*, maltase, sucrase, trehalase, -fructosidase, aminotripeptidase, leucine aminopeptidase, prolinase, glycyl-L-leucine dipeptidase were present. In the gut (tissues and contents of different regions studied separately) in addition to these, melezitase, -glucosidase, -galactosidase, trypsin, glycyl-glycine dipeptidase were also present.

The significance of the synthesis of oligosaccharides in the gut is to avoid hyperglycaemia.

It has been conclusively proved that there are four distinct substrate-specific -glucosidases; and that raffinose is not hydrolyzed by sucrase in *S. inferens*.

### INTRODUCTION

DIGESTION IS A PROCESS of splitting unabsorbable macromolecules of food by digestive enzymes into utilizable and absorbable molecules by addition of water. Thus the study of the digestive enzymes forms an important base for the study of digestive physiology. The present paper reports the digestive enzymes of salivary glands, and tissue and contents of the different regions of gut of *Sesamia inferens*, a sugarcane borer, and clarifies the ambiguity regarding the oligosaccharide synthesis and glycosidase specificity.

### MATERIALS AND METHODS

The field-collected larvae of different ages were reared on sliced sugarcane at 32°C in 6" glass petri dishes; their diet was changed daily. The last instar larvae were dissected after immobilizing by chilling at -10°C for about 10 min. The salivary glands and the gut were taken out and rinsed quickly with distilled water. The contents of fore-, mid-, and hind-gut

were separately collected in distilled water by tearing the wall which was washed to remove the adhering contents. The salivary glands and the gut wall of each region were homogenized separately. These homogenates and the contents were centrifuged at about  $3000 \times g$  for 15 min, and the volume of each supernatant was brought to 1.0 ml by adding distilled water. These supernatants were used as the enzyme source. The reaction mixture contained 0.5 ml of buffer (pH 6.7, 8.2, and 7.0 respectively in case of the enzymes of salivary gland and tissue and contents of foregut, tissue and contents of midgut, and tissue and contents of hindgut); 0.5 ml of 1% substrate; 0.5 ml of enzyme extract and a few drops of toluene. In control mixture the denatured enzyme was taken. Four larvae were used for one test and the presence of the enzymes was detected as described by Agarwal (1975a).

## RESULTS

Table 1 shows the qualitative and comparative quantitative presence of different enzymes. In the salivary glands were present three -glucosidases (maltase, sucrase and trehalase), -fructosidase, aminotripeptidase, leucine aminopeptidase, prolinase and glycyl-L-leucine dipeptidase.

In the foregut tissue the activity of only trehalase was detected although the foregut contents showed the presence of all the enzymes detected in the salivary glands.

In the midgut tissue were present three -glucosidases (maltase, melezitase and trehalase), -glucosidase, -galactosidase, trypsin like enzyme, aminotripeptidase, leucine aminopeptidase, prolinase and glycyl-glycine dipeptidase; while in some experiments a very weak amylase activity was also detected. But in the midgut contents were present all the enzymes of its tissue, and sucrase, -fructosidase and glycyl-L-leucine dipeptidase in addition.

In the hindgut tissue were detected only trehalase, a trypsin-like enzyme, leucine aminopeptidase and prolinase; while its contents showed the activity of all these, and sucrase, -glucosidase, aminotripeptidase, glycyl-L-leucine dipeptidase and glycyl-glycine dipeptidase in addition.

When the larvae fed sugarcane having a high percentage of sucrose, an oligosaccharide not present in sugarcane was detected both in the gut contents and excreta. But when they were fed sugarcane having a low percentage of sucrose, this oligo-

saccharide was neither detected in the gut contents nor in the excreta. The same phenomenon was observed *in vitro* when high and low concentrations of sucrose were used as substrate.

When raffinose was hydrolyzed, fructose and melibiose were produced as the end products.

### DISCUSSION

In considering the carbohydrates available to *S. inferens* larvae feeding on sugarcane, sucrose is of major nutritional value for them, although glucose and fructose are also present in sugarcane. Maltose, melezitose, trehalose, cellobiose, lactose and raffinose can be utilized by the larvae as is reflected by its available enzyme equipment. Among the carbohydrases, sucrase may therefore be considered as the obligatory enzyme and the other carbohydrases as facultative, as long as the larvae feed on sugarcane. The high sucrase activity in the gut of the larvae and abundance of sucrose in the sugarcane supports the view of House (1965), Wigglesworth (1965) and Dadd (1970) that when there is high activity of any enzyme in the gut of an insect, its diet must contain the corresponding substrate in abundance.

The formation of oligosaccharides in the gut (Duspiva, 1953; Srivastava and Auclair, 1962; Srivastava, 1966; Yang and Davis, 1968; Ishaaya and Swirski, 1970; and Takanona and Hori, 1974) and their excretion (Duspiva, 1953; and Srivastava and Auclair, 1962) have been already reported. Duspiva (1953), Srivastava and Auclair (1962), Yang and Davis (1968) and Ishaaya and Swirski (1970) are of opinion that oligosaccharides are produced by the action of invertase on sucrose. It has been further demonstrated that oligosaccharides can also be synthesized in the presence of melezitose and melibiose (Srivastava, 1966), and maltose (Takanona and Hori, 1974). Gilmour (1961) and Dadd (1970) believed that the synthesis of oligosaccharides is due to transglycolysation reaction of  $\alpha$ -glucosidases. On this basis Gilmour (1961) regarded invertase as a sugar-transferring enzyme also, and thus recognized two types of functionally different (Dadd, 1970)  $\alpha$ -glucosidases in insects. In *S. inferens* the production of oligosaccharide is due to reverse catalysis by some glycosidase/s when glucose alone or glucose and fructose both are produced or are present in high concentrations in the gut, as has been pointed out in *Chilotraea infuscatellus* (Agarwal, 1976). Further, the chromatograms of Srivastava and Auclair (1962) also support these observations although their conclusions were different. The oligosaccharide synthesis takes place in an insect as an important measure to limit the diffusion



(absorption) of monosaccharides in the gut when they are in excess and are not needed by the insect. In this manner, hyperglycaemia is avoided in the insect and the oligosaccharide is ultimately excreted. This strategy enables an insect to feed on a variety of diets having varied percentages of utilizable carbohydrates, and therefore the borer continues feeding on sugarcane throughout the year during which period the percentage of sucrose varies widely in sugarcane.

The cane juice contains alanine,  $\alpha$ -aminobutyric acid, aspartic acid, aspergine, glutamic acid, glutamine, glycine, leucine, lysine, proline, serine and valine (Bhattacharya and Mukherjee, 1953). Besides these, arginine, histidine and isoleucine are present in the proteins of sugarcane (Singh and Singh, 1964). Thus proteases must be very important, in order to release these amino acids from the proteins. In this manner only five essential amino acids (Gilmour, 1965; House, 1965; Wigglesworth, 1965; and Dadd, 1970) are available to the borer in the diet. Methionine, phenylalanine, threonine and tryptophan may be regarded as dispensable essential amino acids and if necessary may be obtained by the transaminase system/s possibly present in the borer.

A few enzymes have been detected in the tissue of the foregut and hindgut of *S. inferens*. Evans and Payne (1964) are of opinion that their presence in these tissues does not mean that they are secreted in the respective lumens. The presence of the enzymes in the foregut contents suggests that the digestion of food starts there or rather as soon as the salivary secretion is mixed with the food-stuff. Although the midgut secretes a large variety of enzymes, the most interesting feature is that the sucrase, the most important carbohydrase, is not secreted but reaches there along with the saliva mixed with the food. By observing the proportionate hydrolysis of the substrates in the fore-, mid- and hind-gut, it becomes evident that the major part of digestion occurs in the midgut. The presence of trehalase in the lumen of the intestine of *S. inferens* is a necessary corollary to the mode of sugar absorption in insects, to prevent loss of trehalose (a reserve carbohydrate) by diffusion as explained by Wyatt (1967).

Day and Waterhouse (1953) have pointed out that the ultimate fate of the enzymes is unknown. In *S. inferens* the presence of some enzymes in the midgut and their simultaneous absence in the hindgut suggests that they are either denatured or digested or self-hydrolysed in the posterior part of the midgut.

Similarly, the presence of some enzymes in the hindgut contents but their absence in its tissue and the excreta also suggests their denaturing, digestion or self-hydrolysis in the posterior part of the hindgut. Some enzymes were detected both in the tissue and contents of the hindgut, their absence or low activity in the excreta may be due to their absorption in the hindgut (Agarwal, 1975b). All this appears to be some kind of economical measure to retain as much enzyme protein as possible.

Hopkins (1932) suggested a high specificity of enzymes while Weidenhagen (1932) simultaneously postulated that a general  $\alpha$ -glucosidase is responsible for the hydrolysis of all the  $\alpha$ -glucosides. Weidenhagen's hypothesis continued to prevail till very recently (Fraenkel, 1940; Evans, 1956; Evans and Payne, 1960; Banks, 1963; Evans and Payne, 1964; Zoch, 1965; Khan and Ford, 1967; Dadd, 1970; and Takanona and Hori, 1974) although Pigman (1946), Gottschalk (1950), Neuberg and Mandl (1950), and Gilmour (1961) doubted the hydrolysis of all  $\alpha$ -glucosides by a single enzyme.

A number of workers (Swingle, 1925; Wigglesworth, 1927; Shinoda, 1930; Babers and Woke, 1937; Hopf, 1938; Parkin, 1940; Ricou, 1958; Saxena, 1958; Rastogi and Dutta Gupta, 1962; and Mathur and Thakar, 1969) showed the presence of two separate  $\alpha$ -glucosidases: sucrase (invertase or sacchrase) and maltase on the basis of two different substrates. SooHoo and Dudzinski (1967) doubted the hydrolysis of maltose and sucrose by one enzyme.

Krishna (1958) recognized two types of invertases: one attacking on the fructose moiety of the molecule of raffinose and sucrose, while the other attacking glucose moiety of melezitose and sucrose as suggested by Fraenkel (1940). This view prevailed (Evans, 1956; Khan and Ford, 1962; Krishna and Saxena, 1962; Evans and Payne, 1964; Khan and Ford, 1967; and SooHoo and Dudzinski, 1967) till Dadd (1970) doubted the hydrolysis of both raffinose and sucrose by  $\alpha$ -fructosidase. Banks (1963) and Dadd (1970) believed that the hydrolysis of melezitose and sucrose takes place by the same enzyme.

Evans and Payne (1960) have also suggested that there may be a secretion of more than a single  $\alpha$ -glucosidase in the desert locust. Davis (1963), although not refuting the presence of a generalized  $\alpha$ -glucosidase, stressed on the possibility of maltase, sucrase and trehalase separately. Later on, Evans and Payne (1964) suggested two kinds of carbohydrase specificity. Khan

and Ford (1967) also proposed a possibility of “-glucosidase” actually consisting of a complex of enzymes, each splitting the -glucosidic linkages in different substrates. Agarwal (1975a) showed the presence of four separate -glucosidases on the basis of four different substrates.

This kind of confusion continued probably because four distinct situations were not detected in any insect. In *S. inferens* the four situations are absolutely distinct (Table 2), and therefore, the present observations clearly establish the presence of four different -glucosidases in the gut of this insect and each one of them is substrate-specific.

In *S. inferens*, raffinose is not hydrolyzed by sucrase, as is evident by the presence of sucrase and absence of -fructosidase in the hindgut contents. The presence of -fructosidase is established due to the hydrolysis of raffinose and absence of -galactosidase in *S. inferens*, although many workers have suggested that -galactosidase may hydrolyse raffinose also (Agarwal, 1976). In *S. inferens* melezitose is neither hydrolyzed by -fructosidase nor by sucrase; -fructosidase attacks only between fructose and glucose/melibiose\* moieties of raffinose\*\*.

The presence of a wide variety of enzymes in the gut of the larvae which are not normally required by it may ensure its capacity to adapt to adverse or diverse nutritional conditions, thus enabling the borer to attack successfully maize, sorghum (*Andropogon sorghum*) and Paddy (Gupta, 1937).

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\*Melibiose = glucose-galactose.

\*\*Raffinose = fructose-glucose-galactose

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Table 1. Digestive enzymes in salivary glands and various gut regions of Sesamia inferens.

Enzyme tested	Salivary glands	Foregut		Midgut		Hindgut	
		T	C	T	C	T	C
I. Carbohydrases							
1. Amylase (3.2.1.1)	-	-	-	?	?	-	-
2. Cellulase (3.2.1.4)	-	-	-	-	-	-	-
3. $\alpha$ -glucosidases							
i. Maltase (3.2.1.20)	±	-	±	+	++	-	-
ii. Melezitase	-	-	-	+	++	-	-
iii. Sucrase (3.2.1.26)	+++	-	++	-	+++	-	+
iv. Trehalase (3.2.1.28)	++	+	++	++	+++	+	+
4. $\beta$ -glucosidase (3.2.1.21)	-	-	-	+	++	-	+
5. $\alpha$ -galactosidase (3.2.1.22)	-	-	-	-	-	-	-
6. $\beta$ -galactosidase (3.2.1.23)	-	-	-	+	++	-	-
7. $\beta$ -fructosidase (3.2.1.80)	++	-	±	-	++	-	-
II. Proteases							
1. Trypsin (3.4.4.4)	-	-	-	+	++	±	±
2. Aminopeptidases							
i. Aminotripeptidase (3.4.1.3)	++	-	+	+	+++	-	+++
ii. Leucine aminopeptidase (3.4.1.1)	+	-	+	++	++	+	++
3. Carboxypeptidase (3.4.2.1)	-	-	-	-	-	-	-
4. Dipeptidases							
i. Glycyl-glycine dipeptidase (3.4.3.1)	-	-	-	+	++	-	+
ii. Glycyl-L-leucine dipeptidase (3.4.3.2)	++	-	±	-	++	-	++
iii. Prolinase (3.4.3.6)	+	-	+	+	+++	+	++
iv. Prolidase (3.4.3.7)	-	-	-	-	-	-	-

T = Tissue; C = Contents; - Activity absent; ? Sometimes very weak activity; ± Very weak activity; + Weak activity; ++ Moderate activity and +++ High activity.

Table 2. Hydrolyzing capacity of S. inferens  
 $\alpha$ -glucosidases of salivary glands and  
different gut regions.

Enzyme source	$\alpha$ -glucoside hydrolyzed	$\alpha$ -glucoside not hydrolyzed
Salivary glands	Maltose, sucrose and trehalose.	Melezitose.
Foregut tissue	Trehalose.	Maltose, melezitose and sucrose.
Foregut contents	Maltose, sucrose and trehalose.	Melezitose.
Midgut tissue	Maltose, melezitose and trehalose.	Sucrose.
Midgut contents	Maltose, melezitose, sucrose and trehalose.	
Hindgut tissue	Trehalose.	Maltose, melezitose and sucrose.
Hindgut contents	Sucrose and trehalose.	Maltose and melezitose.

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## RECORDS OF *LIMENITIS* HYBRIDS FROM COLORADO<sup>1</sup>

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DOCUMENTING THE OCCURRENCE OF HYBRIDIZATION of individual animals is important because it allows the records to be utilized by individuals such as Remington (1968) who, for the first time, presented the patterns of hybridization for many invertebrates and vertebrates of the North American continent. This paper deals with four hybrid butterflies, three of which were previously unreported.

The collection of a hybrid (*Limenitis archippus* x *L. weidemeyeri*) was made by Clark Schryver on the Platte River near Denver. It was first recorded (no date) and figured by F. C. Cross (1937) who named the specimen *L. a. weidechippus* (Cross). The Entomology Museum at Colorado State University contains a specimen (Fig. 1 lower left) labeled *L. a. weidechippus* (Cross) which was collected by C. P. Gillette at Fort Collins, Colorado, on 25 August, 1894 (Acc. No. 1747). Recently, the senior author examined another specimen that was collected in Littleton, Colorado, in June 1970, by David Zielsdorf. The literature on other hybrid crosses involving *L. archippus* was reviewed recently by Shapiro and Biggs (1968) and Perkins and Gage (1970). The latter authors comment on the close resemblance of their western hybrids (*L. archippus* x *lorquini*) to the eastern hybrid (*L. archippus* x *arthemis*) (= *arthechippus*) reported by Shapiro and Biggs. The specimens discussed herein bear a striking similarity to those hybrids.

A hybrid (Fig. 1 lower right) between *Limenitis weidemeyeri* Edwards and *L. archippus* Cramer (Fig. 1 top left and

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Fig. 1.—*Limenitis* from Larimer and Weld Co., Colorado. Dorsal surfaces.  
 Top left: *L. archippus* ♂, Weld Co., Colo., 3.VI.73 (TED). Top right: *L. weidemeyeri* ♂, Fort Collins, Colo., 22.VI.68 (RGS). Lower left: *L. archippus* x *weidemeyeri* ♂, Fort Collins, Colo., 25.VII.94 (CPG). Lower right: *L. archippus* x *weidemeyeri* ♂, Larimer Co., Colo., 9.VI.73 (RGS).



Fig. 2.—Ventral surfaces of specimens shown in Fig. 1.



top right) was collected by the senior author along the foothills near Fort Collins on 9 June, 1973. Since the specimen was in excellent condition eclosion must have occurred shortly before capture. A second specimen was observed but not netted about 20 minutes later. Their vigor was evidenced by rapid flight. There was no *L. weidemeyeri* seen flying on the day of capture. However, six days later this species was present in abundance at the collection site which was among willows surrounded, primarily, by native grassland.

This comprises four known hybrid specimens collected in the Denver-Fort Collins area over the past eighty-one years. This area lies in what is referred to as suture-zone IV by Remington (1968) which is used to denote ". . . a band, whether narrow or broad, of geographic overlap between major biotic assemblages, including some pairs of species or semispecies which hybridize in the zone".

### *Analysis of Characters*

The following five characters, similar to those presented by Platt (1975), were used for detailed comparisons among the parental types and the hybrids: (1) traits of ground color of dorsal wings, (2) size and color of the subapical spots on forewings, (3) size and color of submarginal spots on hindwings, (4) character of postmedian white banding on wings and, (5) development of white pattern on ventral surface of abdomen.

*Traits of ground color of dorsal wings.* *L. weidemeyeri* has well-developed black pigmentation over most of the wing surface except where replaced by extensive white banding. The ground color of the wings in *L. archippus* is a rich orange. The hybrid specimens of both species are intermediate in color, but resemble the *L. archippus* phenotype more closely.

*Subapical spots on forewings.* The spots in the subapical area of the forewings are white (4) in *L. weidemeyeri* and orange (5) in *L. archippus*. The hybrids have five spots with a graduation in colors. The two anterior spots are white as in the *L. weidemeyeri* parent, but the three posterior spots are orange as in *L. archippus*.

*Submarginal spots on the hindwings.* In *L. archippus* a conspicuous black limbal line crosses each hindwing. Although present, this line is relatively indistinct in *L. weidemeyeri*. A series of spots immediately distal to the limbal line are designated as the submarginals. Each of the parental species exhibits seven orange submarginal spots which are large and quite conspicuous in *L. archippus*, but typically reduced in *L. weidemeyeri*. Both hybrid specimens are intermediate between the parents in having six moderately well-developed orange spots plus a trace of a seventh.

*Postmedian white banding on wings.* In *L. weidemeyeri* large white bands cross both the fore and hindwings in the postmedial regions. No such banding is present in *L. archippus*. The hybrid specimens show small white spots which represent the white bands in a reduced state. In both specimens there is a series of white spots toward the distal portion of the postmedial region, adjacent to the limbal line, on both the fore and hindwings. This suggests a development gradient of increasing influence of the *L. archippus* genome from the anterior to posterior and from wing base to wing tip.

*White pattern on abdomen.* The white maculae on the abdominal sternites of *L. weidemeyeri* are contiguous forming a longitudinal stripe. The pigmentation on *L. archippus* is restricted and thus forms a series of spots. The hybrids are intermediate; spots are larger than those of *L. archippus* but not sufficient to form a continuous stripe.

### Discussion

An important consideration of the two Fort Collins specimens is that the *L. archippus* parent is rare in the area where the hybrids were taken. There are no records of this species from the immediate vicinity of Fort Collins. The nearest known locality in which it can be consistently collected is near Fort Morgan, Colorado, some 70 miles from the collection site of either hybrid. However, this species has been, on occasion, collected closer to Fort Collins. It can be taken along rivers in the southern and eastern portions of the state according to Brown

(1957), and along some rivers on the western slope. We conclude that both hybrids resulted from the incursion of an individual *L. archippus* into an area devoid of homospecific mates. The lack of appropriate mates resulted in reduced discrimination in the operation of the normal isolation mechanisms and hybrid matings resulted. The two hybrids seen in June of 1973 were very likely siblings since the probability of two such rare organisms occurring in such close proximity is very small unless they had a common origin.

The combinations of traits present in the hybrids pose several intriguing questions concerning the control of expression of colors and patterns. None of the traits appears to be controlled by simple mendelizing alleles. Rather, most appear to be due to systems with no genetic dominance resulting in hybrids which are intermediate between the parents.

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## A RAPID METHOD FOR PRODUCING INSECT LABELS PHILLIP A. ADAMS

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THIS METHOD REPRESENTS A REFINEMENT of Adams 1963. It produces permanent waterproof labels, requires only commonly available materials, and is compact enough for use in the field, if desired. It has proved most convenient for series of 10 to 400 specimens, where the delay in obtaining offset printed labels is undesirable. The description below gives the impression of complexity, but in use the method is both simple and rapid. Engraving the master label takes only a little longer than writing a single label with crowquill. Anyone capable of lettering neatly by hand should have little difficulty in mastering the technique, but practice is necessary to produce best results. These directions have stemmed from extensive experimentation and should be followed meticulously. The essence of the method involves engraving the master label by hand in a thin layer of plaster-like material, and forming a rubber stamp by pressing kneaded rubber into this master. Because of the low relief and delicacy of the stamp, special printing methods are necessary.

The complete kit consists of: coated engraving plates, coating spreader, stylus, 2 pieces of 60x80 mm plate glass, stamp handle, scissors, waxed paper, thumb tacks, foam-covered printing guide and ink pad, ink roller, strips of label paper, kneaded rubber eraser, tube of ink.

The engraving surface is prepared by coating sheets of Formica® with a mixture consisting of 5 parts dry talc, 1 part white glue, and about 2 parts water, by volume, and having the consistency of heavy cream, thick but runny. A good quality facial or U.S.P. talc is preferable; "baby powder" and "body talc" are too coarse. To minimize bubble formation, add water to wet the talc and mix to break up lumps, before adding the glue.



A spreader (Fig. 1) is made from a 15 cm length of metal bar, about 3 mm thick, with a small piece of plastic sponge cemented to each end to prevent the coating mixture from spreading laterally and with several turns of wire wound around each end to serve as a thickness gauge. The thickness of the layer should approximately equal one fourth the height of the letters used. If the layer is too thick there is a tendency for the centers of closed letters such as e, g, d, etc., to break out; if too thin, insufficient relief results in smudging. For letters 1 mm high, No. 28 gauge wire is preferable, and for 0.7 mm letters, No. 30 is better.

The stylus (Fig. 2) is made from a dissecting needle, cut to an 8 mm length, and sharpened. Hold it vertically when engraving. Lettering is closely spaced, preferably filling the entire area of the label. If blank areas are unavoidable, rule a line or a row of dots through them; otherwise, due to the low relief of the stamp, they will print as smudges. Should a blank space be desired, for later addition of data with pen, raise the area on the engraved master with a little white glue. Finally, a border of fine parallel lines is drawn around the engraved label, with a *minimum* width of 6 mm (Fig. 3). Since this border absorbs most of the shock during printing, the wider it is, the better will be the final results. The border area is an unsightly mess when printed, but is entirely trimmed away from the finished label.

The stamp is made from a Eberhard Faber™ kneaded rubber eraser. A small piece is kneaded until soft, flattened with the fingers, then pressed between two small pieces of plate glass, to form a perfectly smooth sheet about 3 mm thick. A piece of this is then cut to the approximate size of the engraved border, and placed on the engraving.

A stamp handle (Fig. 4) is made from a rectangular block of hardwood, with fine wire screen spread over the 20x35 mm face and tacked to the sides; one or two tacks should also be placed on the face of the block. Wrap the edges of the screen with tape. Place the stamp handle over the piece of kneaded rubber, and press firmly into the engraved label. Do not use excessive pressure or the rubber will creep inward later, resulting in a convex stamp surface. Lift the stamp free, and inspect the printing surface, pressing down the edges beyond the engraved border as necessary to prevent smudging (Fig. 5).

The ink pad (Fig. 7) is made from a piece of thin neoprene foam, or fine-grained plastic sponge, cemented to a board. Suitable material is used in skin divers' wet suits, or as backing of



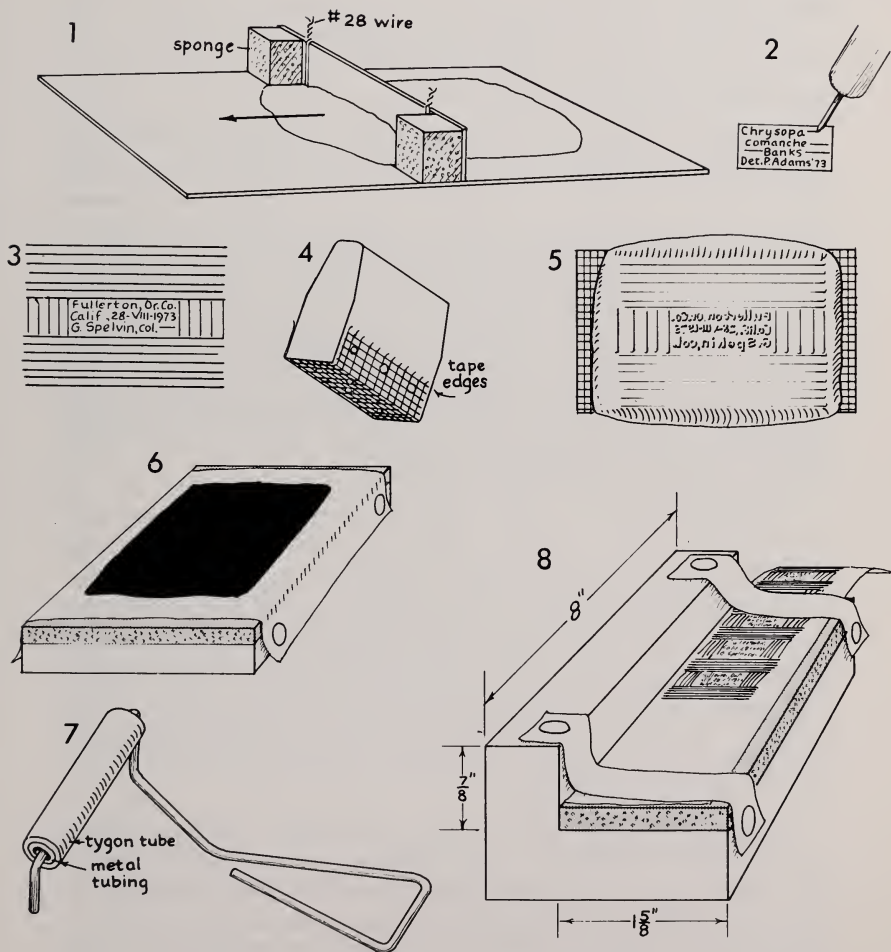


Fig. 1.—Spreading the talc-glue mixture on Formica®.

Fig. 2.—Engraving a label.

Fig. 3.—Complete engraving, with surrounding border.

Fig. 4.—Stamp holder.

Fig. 5.—Stamp ready for printing; excess rubber at edges pressed down as necessary.

Fig. 6.—Stamp pad with wax paper covering.

Fig. 7.—Ink roller.

Fig. 8.—Printing guide.

carpet tiles. Spread a piece of wax paper over the ink pad, and secure with thumbtacks. A small dab of printer's or oil linoleum block printing ink is placed on the wax paper and spread with a small roller (Fig. 6), made from tygon or rubber tubing over a core of metal tubing, and coat-hanger wire. Use little ink, to avoid filling the letters of the stamp.

The paper must have a smooth surface; I prefer Strathmore™ smooth drawing paper, single weight, cut in 1½ inch strips. The paper should be placed on a piece of foam rubber during printing. A printing guide as shown in Figure 8 assists in printing straight rows. Gently ink the stamp, and make a few impressions. Do not press too hard. Usually after about six impressions the stamp flattens out and becomes evenly inked. If necessary, correct the engraved master, wipe the ink from the rubber stamp, knead again, and make another impression. Roll the ink pad frequently to ensure even inking. After about one hundred labels have been produced, the stamp may become so worn that another impression becomes necessary.

Problems. Most of these stem from not appreciating the consequences of the very low relief and delicacy of the stamp; the letters being raised at most a quarter of a millimeter. Open spaces inevitably smudge, so it is necessary to fill the entire area of the label with closely spaced lettering or lines. If the border is too narrow, the edge of the label smudges, and the lettering on the stamp quickly flattens out. Heavy pressure during inking and printing destroys the stamp. This can be avoided by holding the stamp with the thumb and third finger, and pressing gently with the index finger only.

Permanent stamps may be made with latex, silicone rubber, or preferably with quick setting thiokol dental impression rubber. I have not found them convenient; kneaded rubber gives excellent results, and there is no mixing or waiting. Further, with kneaded rubber, it is easy to make corrections in the engraved master as necessary.

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## BOOK REVIEW

RHOPALOCERA DIRECTORY, by John R. Beattie. xiv + 365 pp., Insecta Directory, Volume 1. JB Indexes, 2377 Virginia St., Berkeley, CA 94709, July 1976. Price: \$30.00 to individuals, \$40.00 to libraries.

John Beattie has done a great service to working rhopalocerists of the world. In this compact volume he has listed alphabetically: Genera proposed from 1834-1971, including sub- and supra- generic names (pp. 1-64); and, species names, including subspecies and infrasubspecific ones (pp. 65-292). Two supplements complete the book: an alphabetical series of lists for each of the families recognized, including all of the generic names proposed since 1834 (pp. 293-300) and an inverse-sort of all generic and species names (pp. 301-365). The last is useful and unusual. It is a help running down variant spelling of a name.

There are almost 170,000 entries in the directory. It saves hours of time running down what has been published about a particular genus or butterfly. You can quickly check the use of a name. There is this proviso: the name must appear in either the *Berichte* or the *Zoo. Rec.* For example: *Colorado Butterflies* has never been listed in *Zoo. Rec.* Therefore there is no citation to names in it. Similarly, such books generally are not indexed by species or genus names in *Zoo. Rec.* and you will find no citation to them in the *Directory*. This is not Beattie's fault, it is the fault of *Zoo. Rec.* So long as you recognize that *Zoo. Rec.* is incomplete you will have no trouble. I tested the time-saving involved in a name-search. I hold *Zoo. Rec.* 1920-1971 in my library. It took me over an hour to check and note the inclusions of *Vanessa antiopa* in those volumes. All that I did with the *Directory* was turn to the alphabetic species-list and on p. 80 I found 58 additional references to the 17 I had located from 1920 on. I also found out that there is a 1908 reference under Papilionidae!

The *Directory* is not the whole answer to name problems. It

does not replace Kirby's *Catalogue* . . . nor Sherborn's *Index Animalium* but extends them to a degree. It does not give primary citations, only reference to where in *Berichte* or *Zoo. Rec.* you can find the citation. This is a great help to those with access to these reference books. Thus the *Directory* is not a book for a general collector. It is required addition to the library of individuals, or institutions, carrying on serious research among the Rhopalocera. It is equally useful to African, American, Asian, Australian and European researchers.

Beattie has told me that he hopes to follow this volume with several on moths, the first listing genera, etc. If this is successful, then he plans to do the other orders of insects. More power to him! He has done an immeasurable favor for all serious students of butterflies. I hope he will gain the support needed to carry out his plans.

Note: The *Directory* can be ordered directly from JB Indexes. A ten day trial examination is available.

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SOME PRELIMINARY NOTES ABOUT  
THE IMMATURE STAGES OF *EACLES OSLARI*  
(CITHERONIDAE)

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IN 1972, A RESEARCH PROJECT WAS INITIATED to investigate the relationships between the southern *Eacles* species. A search through the literature revealed that Ferguson (1971), speculated the Texas imperial moth (*E. imperialis nobilis* Neumoegen) acquired its polymorphism by introgression during past contact with *E. oslari* Rothschild, or the ancestor of *oslari*. Ferguson found *oslari* was only from southern Arizona and its immature stages were largely unknown.

In July, 1975, I received 40 ova of *oslari* from Michael Van Buskirk. This note is primarily to report some of the successes and failures of rearing *oslari* on several selected possible foodplants. When the ova arrived, several had already hatched.

Locating the natural Arizona foodplant in Idaho seemed very unlikely, so a series of trials were set up. Based on experience with the rearing of *E. imperialis imperialis* (Drury), several conifers were suspected as possible foodplants. The conifers chosen included the following: colorado blue spruce (*Picea pungens* Engelm.), engelmann spruce (*Picea engelmannii* Parry), lodgepole pine (*Pinus contorta* Dougl.), ponderosa pine (*Pinus ponderosa* Laws.), scotch pine (*Pinus sylvestris* L.), and single-leaf pinyon (*Pinus monophylla* T. & F.).

Blue spruce and scotch pine were placed in a cage together. The larvae placed on blue spruce died without crawling onto the scotch pine. When larvae were placed on scotch pine, feeding began immediately. In addition to scotch pine, larvae also accepted lodgepole and ponderosa pine. In spite of feeding on three species of pine, mortality was high in each instar. All larvae had been held outside until only two remained. These were brought in the house and fed ponderosa foliage. One larva survived to pupate in sand, Figure 1. Extreme changes of environ-



mental conditions between southern Arizona and southern Idaho are probably responsible for the high rate of mortality, as well as inadequate foodplant. It was not established if the same color dimorphism of the larvae occurs with *oslari* that is prevalent with *imperialis*.

### ACKNOWLEDGEMENTS

I wish to thank Mr. Kilian Roever and Mr. Mike Van Buskirk for their efforts in obtaining livestock of *E. oslari* for this project.

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### COVER

Fig. 1.—Last instar larvae of *Eacles oslari* feeding on Ponderosa Pine.

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## THE HEATHII-WHITE BANDING ABERRATION IN THE STRYMONINAE

(LYCAENIDAE)

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ABERRATIONS IN MEMBERS OF THE LYCAENIDAE, as in members of other Lepidoptera groups, are exceedingly rare. Their occurrence within the members of the subfamily Strymoninae are certainly more strikingly pronounced. Unlike aberrations in other groups, this aberration described and illustrated here is a re-occurring and consistent trait, although varying in intensity. The purpose of this paper is to present an account of the "heathii-type" of white banding aberration within species of hairstreaks presently known to the author.

Perhaps the first note of this remarkable aberration was in 1904 with its description by James Fletcher based on one specimen taken in southern Manitoba by E. F. Heath. The specimen was named *Thecla heathii* (see Fletcher, 1904, *Can. Ent.* 36:125-127). Barnes & Benjamin (1926) and McDuunough (1938) list it as a distinct species. Field (1938) mentions that Dr. A. H. Clark informed him that it was an aberration of "*Strymon falacer*." Dos Passos (1964, 1970) correctly treats it as "*ab. heathii*" assigned to *Satyrium calanus falacer* (Godart) in the latter paper.

Stallings & Turner (1943) discuss and figure *heathii* and *heathii*-like *Phaeostrymon alcestitis* (Edwards) taken at one locale the same year in Oklahoma and one of the former (of *S. calanus godarti* (Field)) from Beulah, Colorado. They also list other individual specimens with *heathii* markings in one additional *P. alcestitis* from Oklahoma and an *Euristrymon ontario autolytus* (Edwards) as reported to them by fellow colleagues. Although they mention the condition in *S. tetra* (Edwards) (see Comstock, 1927, Pl. 49, Fig. 14), an examination of material in the collection of the author show the tendency of this condition in that species to be extensive overscaling rather than distinct banding. Brown (1957) briefly notes *heathii* from Colorado as reported by Stallings & Turner and also from specimens taken in the Rabbit Ears Pass region which he figured. More recent

occurrences of all of these as well as in other species has become known to me within the past two years.

The aberration is an over expression of the white scales of the submarginal and post median row of spots, usually on both fore and hindwings of the ventral surface. This produces a white band occupying the vein interspace of these markings. The expression of the condition is variable. It may occupy only a portion of the interspace on either wings or both and may be asymmetrical or completely bilateral. This is well illustrated by comparison of the two *Strymon melinus* (Hubner) in Fig. 1. Some overlap may occur discally or marginally in well expressed examples and may generally affect all white scaling. The blue anal patch on the hindwings may be obscured by white over-scaling but the red-orange spots in the hindwing submarginal series hold true color very well. Distinct banding seems to occur only in those species with broken lines of the maculation described. *E. ontario* (Edwards), *P. alcestis*, *S. melinus* and *S. calanus* (Hubner) are examples. Species with rounded spots forming the discal maculation of both wings aberrate with the white bands forming a distinct arrow shape from the submarginal band members to each discal spot. *S. californica* (Edwards) and *S. acadica* (Edwards) are examples. Figs. 1 and 2 show examples of these aberrations including one example in *Mitoura gryneus castalis* (Edwards). The occurrence of this condition in a wider number of species in the Strymoninae may tend to indicate some genetic origin. This is supported by the frequent occurrence of individuals exhibiting the trait in the population of *S. calanus* in the Rabbit Ears Pass region of Colorado. Whether this is true or a combination of physical factors is unknown, but it is obviously similar occurrences in much varied habitats.

### SUMMARY

The *heathii*-white banding aberration in members of the subfamily Strymoninae has been described in seven species of five genera. There is no trend of this aberration to favor one sex, although collection of additional examples may show this in some species in certain areas. No new names are suggested to apply to this condition in those species previously unreported with the character. The name *heathii* of course will be retained as the classic example of this remarkable condition. The character best show the relationship of species and subspecies within the



1

Fig. 1.—Left to right, Top Row: *S. calanus falacer* ab. *heathii* (typical), 2 mi. N.W. Croton Dame, Newaygo Co., Michigan, 10 vii 71, leg. J. Haf-ernik (compliments of Mogens Nielsen); *S. calanus* ssp., Rabbit Ears Pass, Routt Co., Colorado, 22 vii 73, leg. Mike Fisher; *S. calanus* ssp., 5 mi. S. Fayetteville, Washington Co., Arkansas, 27 v 72, leg. and compliments of J. R. Heitzman; Bottom Row: *S. melinus humuli* (Harris), Allegan State Game Area, Allegan Co., Michigan, 5 vii 75, leg. and compliments of Irwin Leeuw; *S. melinus franki* (Field), .4 mi. E. Boxelder Creek, Arapahoe Co., Colorado, 4 viii 74, leg. Mike Fisher; *P. alcestis*, Medicine Lodge, Barber Co., Kansas, 2 vi 74, leg. and compliments of J. R. Heitzman.

**2**

Fig. 2.—Left to right, Top Row: *S. acadica*, Lansing, Ingham Co., Michigan, 10 vii 51, leg. R. Hodges (compliments of Mogens Nielsen); *S. californica*, Yosemite, California 28 vi 37, compliments of Julian P. Donahue, L.A. Co. Museum collector; Bottom Row: *E. ontario* ssp., Fayetteville, Washington Co., Arkansas, 27 v 71, leg. and compliments of J. R. Heitzman; *M. gryneus castalis*, Bastrop State Park, Bastrop Co., Texas, 12 vi 68, leg. and compliments of J. R. Heitzman.



subfamily not only within species complexes but between them and also across generic lines in dissimilar species. This trait may also represent the characteristic maculation found in the ancestral species common to the members of this subfamily. It is truly a unique character within the subfamily and is expected to occur, though very rarely, in other members within it.

### ACKNOWLEDGEMENTS

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## HABITAT: *PIERIS OCCIDENTALIS* (PIERIDAE)

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THE WESTERN WHITE, *Pieris occidentalis* Reakirt, is best known to most collectors as a hilltopping species or as a resident of alpine meadows. In such situations it is seldom observed at high density. Like its lowland sibling *P. protodice* Boisduval and LeConte, *P. occidentalis* is preadapted to disturbed, man-made environments and when suitable conditions arise within its altitudinal range it may exploit them and become very abundant. The photograph is of the railroad yard at Norden, California, in Donner Pass at an elevation of about 7000 feet, 28 September 1973. Here the weedy Crucifer *Lepidium virginicum* var. *pubescentis* is very abundant and *P. occidentalis* bred at high density in 1973, mating without hilltopping under conditions in which freshly emerged females were readily available (Shapiro, 1975). *P. protodice*, which apparently does not overwinter at Donner Pass, also successfully colonized this railroad yard, coexisting with *P. occidentalis* in 1973. Males of both species patrolled the bare-soil area constantly in sunshine. *P. rapae* Linnaeus bred along the stream bed at the foot of the slope, using the native Crucifer *Rorippa curvisiliqua*.

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## MELANIC *PAPILIO MACHAON* LARVAE

Although melanic imagines are now well-known, being in certain species and areas even commoner than the types, melanism among larvae is not so well documented. In the colonies of *P. machaon*, L., resident around the Broads of Norfolk, England, occasional melanic imagines occur. The larva shown alongside the type above, was one of many that turned up in the offspring of a number of chrysalids sent me for breeding some years ago. From a quarter to a half of several hundred larvae were of this form. All produced normal adults. It is probably caused by a simple recessive allele, but accurate breeding results, for various reasons, were unfortunately not possible.

Brian O. C. Gardiner



Continued from 15(2):109-128

vicinity of Lago Catemaco. Most butterflies were taken as they imbibed sap oozing from the trunks of citrus trees. The flight is rapid, erratic, and usually between three and five feet of the ground.

214. *Anaea (Zaretis) callidryas* (Felder)

SPECIMENS: 2 ♂♂, 3 ♀♀; 1,100 feet; 7 Sept.-9 Oct.

This *Anaea* is uncommon and seasonal; all butterflies were collected during fall and along Hedgerows in the Catemaco Basin. The flight is similar to that of other members of the genus.

215. *Anaea (Anaea) aidea* Guérin-Ménéville

SPECIMENS: 21 ♂♂, 16 ♀♀; 1,100 feet; 21 June-10 Nov.

This leaf wing is abundant throughout the Catemaco Basin but uncommon in all other sections of the Sierra. The butterflies were collected in Pastures, along Hedgerows and the margins of the Semi-Evergreen Seasonal Forest. *Croton soliman* is the larval food plant. Butterflies collected in late summer (late August) and fall (September-November) are slightly different in coloration—the dorsal surfaces of the wings are deeper orange and the ventral surfaces are darker brown with more streaking and blotching—than those collected in early and mid summer. The flight is similar to that of most other members of the genus.

216. *Anaea (Consul) fabius* (Cramer)

SPECIMENS: 5 ♂♂, 10 ♀♀; 150-2,450 feet; 23 July-26 Oct.

This species is locally common and found primarily along the margins of and just within the small sections of disturbed Semi-Evergreen Seasonal Forest bordering Lago Catemaco. Within the shaded and semi-shaded areas of the forest, the butterflies usually fly approximately six feet above the ground with a relatively slow and weak wing beat, which is very atypical for members of the genus but very similar to that of the "tiger complex" of ithomiids and several heliconians—particularly *H. ismenius*, the predominant butterfly species within these forests. However, when the butterflies are disturbed or engaged in pursuing each other (as is quite frequently the case when they enter the sunny pastures) the flight becomes typical of that of most members of the genus—fast, erratic, and with frequent darting motions.

217. *Anaea (Consul) electra* (Westwood)

SPECIMENS: 11 ♂♂, 4 ♀♀; 700-2,950 feet; 22 June-7 Sept.

*Anaea electra* is locally common, being found principally



along the margins of the Semi-Evergreen Seasonal Forest, Lower Montane Rain Forest, and Hedgerows in the Catemaco Basin.

However, occasionally butterflies were seen along the borders of the Montane Rain Forest. The flight usually is higher than that of most species of *Anaea*—usually in excess of 15 feet of the ground and often near the boles of the tallest trees.

218. *Anaea (Memphis) eurypyle confusa* Hall

SPECIMENS: 6 ♂♂, 6 ♀♀; 800-2,700 feet; 10 March-26 Oct.

This species is locally common and found primarily in the Deciduous Woodland and the *Pinus-Quercus* Associates. In fact, *A. eurypyle confusa* is the most common species of *Anaea* on the Santa Marta massif. The butterflies were seen most frequently on a grassy, shrubby knoll northeast of Ocotál Chico as they rested on stalks of grass and twigs. The flight is very rapid and erratic.

219. *Anaea (Memphis) artacaena* (Hewitson)

SPECIMEN: 1 ♀; 1 mi. N. Soteapan, 1,400 feet, 14 July 1963.

The single specimen of this rare species was collected as it flew about the flowers of *Lindenia rivalis*, a common shrub in the streams and creeks on the Santa Marta massif and in the Semi-Evergreen Seasonal Forest.

220. *Anaea (Memphis) pithyusa* (Felder)

SPECIMENS: 4 ♂♂, 3 ♀♀; 1,100-1,900 feet; 14 July-13 Nov.

This species is uncommon. The butterflies were collected in a variety of habitats—Pastures (as they imbibed fermenting citrus sap), Recently Abandoned Milpas (as they rested on dead branches), and along the margins of the Semi-Evergreen Seasonal Forest (as they rested on sunlit leaves). The behavior is typical of most members of the genus.

221. *Anaea (Memphis) proserpina* (Salvin)

SPECIMENS: 5 ♂♂; 3 mi. NNW Ocotál Chico, 4,800 feet, 17 June 1963, 1 ♂; Peak Volcán Santa Marta, 5,000 feet, 11 June 1963, 2 ♂♂; 17 June 1963, 1 ♂; 1 March 1965, 1 ♂.

*Anaea proserpina* is uncommon and found only in the Montane Thicket and Elfin Woodland on the upper slopes of Volcán Santa Marta. The butterflies were seen most frequently as they chased each other about in or slightly below the forest canopy; only rarely did an individual descend within netting range. The species has not been recorded from the state. The nearest recorded locale is Chiapas (Comstock, 1961).

222. *Anaea (Memphis) morvus boisduvali* W. P. Comstock

SPECIMENS: 2 ♀ ♀, 9 mi. ENE Sontecomapan, 0 feet, 13

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Aug. 1962, 1 ♀; 14 Aug. 1962, 1 ♀.

This species is rare. Both females were collected as they rested on tree limbs in the Littoral Woodland near Río Carizal.

#### SUBFAMILY Libytheinae

223. *Libytheana carinenta mexicana* Michener

SPECIMENS: 8 ♂ ♂, 6 ♀ ♀; 1,100-2,100 feet; 23 Oct.-22 Nov.

The Mexican snout butterfly is locally abundant and seasonal, being found primarily in the *Pinus-Quercus* Associates of the Deciduous Woodland during late fall. Most butterflies were collected as they visited the flowers of *Calliandra grandiflora*. On several occasions I observed as many as a dozen butterflies on a single plant. The flight is very rapid, erratic and usually between six and 12 feet of the ground.

#### FAMILY LYCAENIDAE

#### SUBFAMILY Lycaeninae

TRIBE Theclini

SUBTRIBE Strymoniti

224. *Eumaeus minyas* Hübner

SPECIMENS: 18 ♂ ♂, 14 ♀ ♀; 0-2,200 feet; 5 Feb.-30 Oct.

This lycaenid is abundant in the *Pinus-Quercus* Associates of the Deciduous Woodland and in the Littoral Woodland behind the coast where *Piper* sp. is common. The butterflies were collected most frequently as they fed on the blossoms of *Calliandra grandiflora* (in the pine-oak forest) and as they rested on the leaves of *Piper* sp. (in the Littoral Woodland). The flight is extremely slow, weak, usually between two and eight feet of the ground, and of short duration. When the butterflies were pinched, small droplets of brownish, acrid-smelling liquids were exuded from the terminal portions of the appendages and the wing veins. The larval food plant is *Zamia loddigesii* var. *angustifolia*, a common plant in the pine-oak forest. Immature stages are described in Ross (1964d).

225. *Eumaeus debora* Hübner

SPECIMENS: 15 ♂♂, 16 ♀♀; 2 mi. NE Catemaco, 1,100 feet, 30 July 1963, 2 ♂♂, 1 ♀: 1.5 mi. SW Margiallanas, 1,500 feet, 5 Aug. 1963, 1 ♀: 2 mi. WSW Tapalapan, 1,600 feet, 13 Oct. 1962, 3 ♂♂, 1 ♀: 1.5 mi. NNE Ocotál Chico, 2,300 feet, 10 July 1963, 1 ♀: 1 mi. N Ocotál Grande, 3,000 feet, 21 June 1963, 1 ♀: Peak Volcán San Martín Pajapan, 3,750 feet, 8 June 1965, 1 ♀: 3 mi. NNW Ocotál Chico, 3,800 feet, 11 June 1963, 1 ♀; 4,100 feet, 11 June 1963, 1 ♀. Reared specimens: 3 mi. NNE Ocotál Chico, 3,200 feet, emerged 29 Aug. 1963, 1 ♂, 1 ♀: 2 mi. N Ocotál Grande, 3,600 feet, emerged 12 May 1965, 5 ♂♂, 2 ♀♀; 13 May 1965, 4 ♂♂, 3 ♀♀.

This large lycaenid is locally common in the Montane Rain Forest, Montane Thicket, and Elfin Woodland during late summer and fall. The butterflies seem to prefer to fly in the relatively bright and open sections of the forest as well as over the peaks of the highest volcanoes. The flight is very similar to that of *E. minyas* with the exception that *E. debora* usually flies at higher altitudes, usually between ten and 20 feet of the ground. The larval food plant is *Ceratozamia mexicana*, a common plant in the rain forests between elevations of 3,000 and 3,500 feet. The life history is described in Ross (1964d). The species has been recorded from Veracruz only from the "Sierra Madre Oriental" (Hoffmann, 1940).

226. *Theorema eumenia* Hewitson

SPECIMENS: 2 ♂♂; 1 mi. NNW Ocotál Grande, 1,900 feet, 4 July 1963, 1 ♂: 3 mi. NNW Ocotál Chico, 2,900 feet, 17 June 1963, 1 ♂.

This species is rare; one specimen was collected along a small stream in a ravine within the Semi-Evergreen Seasonal Forest, and the other in a ravine within the Lower Montane Rain Forest. Both butterflies were resting on the upper surfaces of leaves along shaded sections of trails when collected.

227. *Chlorostrymon simaethis simaethis* (Drury)

SPECIMENS: 2 ♂♂, 1 ♀; 0.5 mi. S Barrosa, 500 feet, 30 June 1962, 1 ♀: 4 mi. NE Catemaco, 1,100 feet, 22 July 1962, 1 ♂: 2 mi. NE Catemaco, 1,100 feet, 4 Oct. 1962, 1 ♂.

This hairstreak is rare; all three specimens were collected as they fed on *Cordia spinescens* growing along Hedgerows. The behavior of this species is typical of all the remaining species in the tribe Theclini recorded from the Sierra: first, a flight that is

extremely rapid, erratic, and which tends towards the vertical more than the horizontal; second, a resting position that usually is on the upper surfaces of leaves and during which time the butterflies usually rub their hind wings together alternately.

228. *Chlorostymon telea* (Hewitson)

SPECIMENS: 2 ♂♂, 1 ♀; 1,200-2,000 feet; 9 June-1 Aug.

All three specimens of this uncommon species were collected in Pastures as they fed on the blossoms of *Cordia spinescens*.

229. *Calycopis beon* (Cramer)

SPECIMENS: 27 ♂♂, 10 ♀♀; 0-3,400 feet; 11 Feb.-30 Oct.

The beon hairstreak is the most abundant and widespread species of lycaenid in the Sierra, being found in practically all open and semi-shaded areas. The behavior is similar to that of most members of the family.

230. *Calycopis trebula* (Hewitson)

SPECIMENS: 5 ♂♂; 1,700-1,900 feet; 17 May-8 Aug.

This species is locally common and found primarily along the margins of the Semi-Evergreen Seasonal Forest on the Santa Marta massif. All butterflies were collected as they rested on the leaves of trees growing along shaded stream banks.

231. *Calycopis pisis* (Godman & Salvin)

SPECIMENS: 1 ♂, 1 ♀; 2 mi. N Ocotil Grande, 3,700 feet, 21 June 1963.

This species is rare and restricted to the *Liquidambar-Quercus* Associates of the Montane Rain Forest. Both specimens were collected as they rested on leaves along a partially shaded trail. *Calycopis pisis* has not been recorded from Mexico; the nearest recorded locale is Teleman, Guatemala (Godman & Salvin, 1879-1901).

232. *Calycopis* sp. "C"

SPECIMEN: 1 ♂; 2 mi. SSW Tibernal, 150 feet, 23 Aug. 1962.

This specimen still remains unclassified. The butterfly was collected along the margin of the *Bursera-Sabal-Orbignya* Associates of the Semi-Evergreen Seasonal Forest.

233. *Tmolus echiolus echiolus* (Draudt)

SPECIMEN: 1 ♀; 1 mi. NNE Ocotil Chico, 2,100 feet, 14 June 1963.

This hairstreak is rare. The single specimen was collected as it fed on the blossoms of *Cordia spinescens* that was growing in a Recently Abandoned Milpa.



234. *Tmolus crolinus* (Butler & Druce)

SPECIMENS: 6 ♂♂, 2 ♀♀; 1,100-2,800 feet, 2 June-3 Aug.

*Tmolus crolinus* is uncommon but relatively widely distributed throughout the range, being found principally along the margins of Hedgerows, the Semi-Evergreen Seasonal Forest, and Deciduous Woodland (including the *Pinus-Quercus* Associates). The butterflies are attracted to the flowers of *Calliandra grandiflora*.

235. *Tmolus azia* (Hewitson)

SPECIMENS: 3 ♂♂, 4 ♀♀; 1,100-2,200 feet; 5 Feb.-4 Oct.

This *Tmolus* is locally common and found primarily on the leaves and flowers of *Borreria suaveolens* in Pastures and Recently Abandoned Milpas. Although I searched for immature stages, none was found.

236. *Oenomaus ortygnus* (Cramer)

SPECIMENS: 4 ♂♂, 4 ♀♀; 900, 1,000 feet; 17 July-7 Sept.

This lycaenid is locally common. Most butterflies were collected in shaded and semi-shaded areas along the margins of or just within the Semi-Evergreen Seasonal Forest and Lower Montane Rain Forest in the vicinity of Lago Catemaco.

237. *Callophrys (Cyanophrys) amyntor distractus* Clench

SPECIMENS: 1 ♂, 5 ♀♀; 700-1,800 feet; 20 June-18 Oct.

This species is uncommon and local. Most specimens were collected as they rested on the leaves of trees and shrubs growing along the margins of the Lower Montane Rain Forest and the Semi-Evergreen Seasonal Forest in the vicinity of Lago Catemaco. The behavior is the same as that of other species in the tribe.

238. *Callophrys (Cyanophrys) herodotus* (Fabricius)

SPECIMENS: 3 ♂♂, 3 ♀♀; 0-2,200 feet; 22 April-18 Sept.

*Callophrys herodotus* is uncommon and found along the margins of the Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Swamp Forest.

239. *Callophrys (Cyanophrys) leucania* (Hewitson)

SPECIMEN: 1 ♀; 1 mi. N Ocotal Grande, 2,300 feet, 15 May 1965.

The single female of this rare species was collected as it fed on the blossoms of *Calliandra grandiflora* growing in the *Pinus-Quercus* Associates of the Deciduous Woodland.

240. *Callophrys (Cyanophrys) miserabilis* (Clench)

SPECIMENS: 2 ♀♀; 2 mi. NE Catemaco, 1,100 feet, 15 Sept. 1962.



Both females of this rare species were collected as they fed on the blossoms of *Crotalaria vitellina*, which was growing in a Hedgerow.

241. *Callophrys* (*Cyanophrys*) *goodsoni* Clench

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 7 Sept. 1962.

The single male was collected as it fed on the blossoms of *Cordia spinescens* in a Pasture.

242. *Callophrys* (*Cyanophrys*) *agricolor agricolor* (Butler & Druce)

SPECIMEN: 1 ♂: Peak, Volcán Santa Marta, 5,200 feet, 6 April 1965.

The single specimen of this rare species was collected as it flew over the crater rim of Volcán Santa Marta. The flight is very rapid and erratic.

243. *Callophrys* (*Cyanophrys*) nr. *longula* (Hewitson)

SPECIMEN: 1 ♀; Peak Volcán Santa Marta, 5,100 feet, 26 May 1965.

This species is rare. The single female was collected as it flew over the peak of Volcán Santa Marta and above the canopy of the Elfin Woodland. Although there are similarities between the female and those of *C. longula*, there are several differences. In addition, *C. longula* is restricted to South America—Ecuador, Bolivia, Colombia, and Venezuela (Godman & Salvin, 1879-1901). Therefore, the female from the Sierra probably represents a new species.

244. *Atlides polybe* (Linnaeus)

SPECIMEN: 1 ♂; 3 mi. SW Sontecomapan, 900 feet, 17 July 1962.

*Atlides polybe* is rare in the Sierra. The single male was collected as it fed on the blossoms of *Cordia spinescens* in a Pasture.

245. *Panthiades ochus* (Godman & Salvin)

SPECIMEN: 1 ♂; 3 mi. SW Sontecomapan, 900 feet, 17 July 1962.

The single specimen was collected as it fed on the blossoms of *Cordia spinescens*, which was growing in a Hedgerow.

246. *Strymon melinus* Hübner

SPECIMENS: 6 ♂ ♂, 9 ♀ ♀; 0.25 mi. SSE Ocotál Chico, 1,700 feet, 8 June 1963, 1 ♀: 0.5 mi. SSE Ocotál Chico, 1,800 feet, 23 June 1963, 1 ♀: Ocotál Chico, 1,900 feet, 15 May 1965, 1 ♀; 7 July 1963, 1 ♂; 28 Oct. 1962, 2 ♂ ♂: 1 mi. NNE Ocotál Chico, 2,100 feet, 14 June 1963, 1 ♂: 5 mi. NNE Catemaco, 2,200 feet,

4 July 1962, 1 ♂ : 1 mi. N Ocotal Grande, 2,300 feet, 15 May 1965, 3 ♀ ♀ : 1 mi. NNW Ocotal Chico, 2,300 feet, 3 July 1963, 1 ♀ : 1.5 mi. NNW Ocotal Chico, 2,350 feet, 15 June 1963, 1 ♀ : 1.25 mi. NE Ocotal Chico, 2,600 feet, 10 May 1965, 1 ♂ ; 2,700 feet, 28 July 1963, 1 ♀ .

The grey hairstreak is locally common. Most specimens were collected as they fed on the blossoms of *Calliandra grandiflora* in the *Pinus-Quercus* Associates of the Deciduous Woodland. The behavior is the same as that of other members of the tribe. *Strymon melinus* has not been recorded from Veracruz. The nearest recorded locale is Oaxaca (Hoffmann, 1940).

247. *Strymon yojoa* (Reakirt)

SPECIMENS: 10 ♂ ♂ , 14 ♀ ♀ ; 500-5,000 feet; 11 Feb.-26 July.

This species is abundant throughout most open and semi-open areas throughout the Sierra. The butterflies are attracted to many species of flowering plants.

248. *Strymon columella istapa* (Reakirt)

SPECIMENS: 4 ♂ ♂ ; 1,100-2,700 feet; 12 May-10 Oct.

The columella hairstreak is uncommon. All butterflies were collected as they visited the blossoms of *Calliandra grandiflora* in Hedgerows and the *Pinus-Quercus* Associates of the Deciduous Woodland.

249. *Strymon bazochii* (Godart)

SPECIMENS: 3 ♂ ♂ , 1 ♀ ; 1,100-2,200 feet; 7 June-21 Aug.

The bazochii hairstreak is uncommon and found in Pastures, the *Pinus-Quercus* Associates of the Deciduous Woodland, and along Hedgerows.

250. *Strymon albata sedecia* (Hewitson)

SPECIMENS: 2 ♀ ♀ ; 2 mi. NE Catemaco, 1,100 feet, 9 Aug. 1962, 1 ♀ ; 21 Aug. 1962, 1 ♀ .

Both individuals of this rare species were collected along the margins of the Semi-Evergreen Seasonal Forest in the vicinity of Lago Catemaco.

251. *Strymon serapio* Godman & Salvin

SPECIMENS: 2 ♂ ♂ , 1 ♀ ; 2,200, 2,500 feet; 10 March, 28 June.

This species is uncommon. All butterflies were collected as they fed on the blossoms of *Calliandra grandiflora* in the Deciduous Woodland.

252. *Electrostrymon cyphara* (Hewitson)

SPECIMENS: 5 ♂ ♂ , 10 ♀ ♀ ; 700-2,700 feet; 15 June-15 Sept.

*Electrostrymon cyphara* is locally common, being found pri-

marily in the *Pinus-Quercus* Associes of the Deciduous Woodland and along the margins of the Semi-Evergreen Seasonal Forest and Lower Montane Rain Forest. The behavior is typical of that of other members in the tribe.

253. *Cynus battus jala*n (Reakirt)

SPECIMENS: 9 ♂♂, 3 ♀♀; 0-2,700 feet; 14 March-29 Oct.

This lycaenid is common. Most butterflies were collected as they fed on the blossoms of *Cordia spinescens* in Pastures and along Hedgerows.

254. *Arawacus aetolus togarna* (Hewitson)

SPECIMENS: 2 ♂♂, 1 ♀; 800-1,900 feet; 14 June-23 July.

This white hairstreak is uncommon and found primarily along the margins of the Lower Montane Rain Forest and Semi-Evergreen Seasonal Forest.

255. *Arawacus sito* (Boisduval)

SPECIMENS: 14 ♂♂, 9 ♀♀; 900-3,200 feet; 18 March-18 Nov.

*Arawacus sito* is common and found most frequently on the blossoms of *Cordia spinescens* in Pastures and along Hedgerows.

256. *Heterosmaitia paleon* (Cramer)

SPECIMENS: 6 ♂♂, 9 ♀♀; 700-2,700 feet; 27 April-15 Sept.

This species is common and widely distributed throughout the Sierra, being found in most open and sunny areas irrespective of plant formation.

257. *Allosmaitia pion* (Godman & Salvin)

SPECIMENS: 2 ♂♂, 3 ♀♀; 1,100-2,400 feet; 6 June-21 Aug.

This lycaenid is uncommon. All butterflies were collected as they fed on the flowers of *Cordia spinescens* in Pastures and the *Pinus-Quercus* Associes of the Deciduous Woodland.

258. *Evenus regalis* (Cramer)

SPECIMEN: 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 28 Aug. 1963.

The single female of this rare species was collected as it fed on the flowers of *Cordia spinescens* in a Pasture.

259. *Thecla cypria* (Geyer)

SPECIMEN: 1 ♀; 2 mi. SW Sontecomapan, 900 feet, 12 July 1962.

This species is rare. The single female was collected as it fed on an unidentified composite in a Pasture.

260. *Thecla marsyas damo* (Druce)

SPECIMENS: 4 ♂♂, 10 ♀♀; 0-2,300 feet; 23 June-7 Sept.

This hairstreak is common, particularly in the Catemaco

Basin. The butterflies were seen most frequently along the margins of the Semi-Evergreen Seasonal Forest and Hedgerows. The behavior is the same as that of most other members of the family.

261. *Thecla augustula* Kirby

SPECIMEN: 1 ♂; 1.5 mi. NNW Ocotál Grande, 1,800 feet, 4 July 1963.

The single male was collected as it rested on an oak leaf approximately six feet above the ground in the *Pinus-Quercus* Associates of the Deciduous Woodland.

262. *Thecla lisus* Stoll

SPECIMENS: 2 ♂; 1 mi. N Soteapan, 1,400 feet, 14 July 1963.

This hairstreak is rare; both males were collected as they rested on leaves of *Lindenia rivalis*, a common plant in the shallow streams within the Semi-Evergreen Seasonal Forest on the Santa Marta massif.

263. *Thecla mavors* (Hübner)

SPECIMENS: 5 ♂, 1 ♀; 1,100-2,700 feet; 11 Feb.-26 June.

This species is uncommon and found principally along the margins of the *Liquidambar-Quercus* Associates of the Montane Rain Forest and Hedgerows on the Santa Marta massif. Most butterflies were collected as they rested on leaves approximately two to five feet above the ground.

264. *Thecla inachus carpophora* Hewitson

SPECIMENS: 2 ♂; 2 mi. SW Sontecomapan, 1,100 feet, 23 July 1962, 1 ♂: 2 mi. NE Catemaco, 1,100 feet, 28 Aug. 1963, 1 ♂.

This rare species was collected in small patches of Semi-Evergreen Seasonal Forest in the vicinity of Lago Catemaco. Both butterflies were collected as they rested on leaves along shaded trails.

265. *Thecla neora* Hewitson

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 29 Aug. 1963.

The single male was collected as it fed on the blossoms of *Cordia spinescens* in a Hedgerow.

266. *Thecla laothoe* Godman & Salvin

SPECIMEN: 1 ♂, Peak Volcán Santa Marta, 5,200 feet, 6 April 1965.

The single male was collected as it flew over the crater rim of Volcán Santa Marta and above the canopy of the Elfin Woodland.

267. *Thecla barajo* Reakirt

SPECIMENS: 1 ♂, 2 ♀ ♀; 900-2,700 feet; 21 April-30 Aug.

*Thecla barajo* is rare; all specimens were collected as they fed on the blossoms of *Cordia spinescens* growing in Hedgerows.268. *Thecla janias* (Cramer)

SPECIMENS: 2 ♀ ♀; 2 mi. NE Catemaco, 1,100 feet, 21 Aug. 1962, 1 ♀: 1 mi. NNE Ocotál Chico, 2,000 feet, 31 May 1965, 1 ♀.

This species is rare. Both females were collected as they fed on the flowers of *Cordia spinescens* in Pastures.269. *Thecla hassan* (Stoll)

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 21 Aug. 1962.

The single male was collected as it fed on the blossoms of *Cordia spinescens* in a Hedgerow.270. *Thecla meton* (Cramer)

SPECIMENS: 7 ♂ ♂, 2 ♀ ♀; 800-1,900 feet; 28 June-26 Sept.

*Thecla meton* is common in most Pastures and along most Hedgerows throughout the Sierra. The behavior is similar to that of other members of the tribe.271. *Thecla janthina janthodonia* Dyar

SPECIMENS: 3 ♂ ♂, 1 ♀; 1,100 feet; 25 July-17 Sept.

This lycaenid is uncommon and found principally along Hedgerows and in Pastures in the vicinity of Lago Catemaco. The butterflies are attracted to the blossoms of *Cordia spinescens*.272. *Thecla* nr. *polibites* (Cramer)

SPECIMEN: 1 ♂; Ocotál Chico, 1,900 feet, 22 June 1963.

The single male of this rare species was collected as it rested on a leaf of a small tree growing along the bank of a stream in the Semi-Evergreen Seasonal Forest. The single specimen is worn and so the determination cannot be definite.

273. *Thecla vibidia* Hewitson

SPECIMEN: 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 28 Aug. 1963.

The single specimen was collected as it fed on the blossoms of *Cordia spinescens* in a Pasture along the southwest shore of Lago Catemaco.274. *Thecla hecate* Godman & Salvin

SPECIMENS: 1 ♂, 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 24 Sept. 1962, 1 ♀: 5 mi. NNE Catemaco, 2,200 feet, 4 July 1962, 1 ♂.

This hairstreak is rare. Both specimens were collected as they fed on the flowers of *Cordia spinescens* in Pastures.



275. *Thecla jebus* (Godart)

SPECIMEN: 1 ♂ ; 2 mi. NE Catemaco, 1,100 feet, 2 July 1962.

*Thecla jebus* is rare. The single specimen was collected as it rested on a leaf along the margin of a small section of Semi-Evergreen Seasonal Forest bordering Lago Catemaco.

276. *Thecla brescia* Hewitson

SPECIMENS: 3 ♂ ♂ , 8 ♀ ♀ ; 1,100-2,400 feet; 17 March-4 Oct.

This lycaenid is locally common and restricted to the Deciduous Woodland including the *Pinus-Quercus* Associates. Most butterflies were collected as they fed on the blossoms of *Calliandra grandiflora*.

277. *Thecla ligurina* Hewitson

SPECIMEN: 1 ♀ ; 2 mi. NE Catemaco, 1,100 feet, 27 June 1962.

The single specimen of this rare species was collected as it rested approximately seven feet above the ground on the leaf of *Inga spuria* in a Pasture.

278. *Thecla mycon* Godman & Salvin

SPECIMENS: 7 ♂ ♂ , 3 ♀ ♀ ; 1,100 feet; 20 June-5 Nov.

*Thecla mycon* is common only in the Catemaco Basin. Most butterflies were collected as they rested on leaves in shaded or partially shaded areas along the margins of Hedgerows and the Semi-Evergreen Seasonal Forest. The behavior is characteristic of other members of the tribe.

279. *Thecla thales* (Fabricius)

SPECIMENS: 2 ♀ ♀ ; 3 mi. NNW Ocotil Chico, 2,900 feet, 9 Feb. 1965, 1 ♀ ; 3 July 1963, 1 ♀ .

Both specimens of this rare species were collected as they rested on leaves approximately nine feet above the ground along the margin of the *Liquidambar-Quercus* Associates of the Montane Rain Forest.

280. *Thecla tephraeus* (Geyer)

SPECIMENS: 5 ♂ ♂ , 3 ♀ ♀ ; 800-2,500 feet; 16 June-22 Aug.

This hairstreak is common and relatively widely distributed throughout the Sierra, being found principally in Pastures and along Hedgerows where *Cordia spinescens* was growing.

281. *Thecla syncellus syncellus* (Cramer)

SPECIMENS: 3 ♂ ♂ , 5 ♀ ♀ ; 0-1,900 feet; 29 June-29 Aug.

Although uncommon, this species is fairly widely distributed throughout the Sierra. Most butterflies were collected as they rested on leaves along the partially shaded margins of the Semi-Evergreen Seasonal Forest and Hedgerows.

282. *Thecla minthe* Godman & Salvin

SPECIMEN: 1 ♀; 5 mi. NNE Catemaco, 2,200 feet, 4 July 1962.

The single female was collected as it rested on a leaf approximately three feet above the ground in a relatively dense section of Lower Montane Rain Forest.

283. *Thecla empusa* Hewitson

SPECIMENS: 1 ♂; 2 ♀ ♀; 2,200, 2,700 feet; 16 June-1 July.

*Thecla empusa* is uncommon and restricted to the Deciduous Woodland and the *Liquidambar-Quercus* Associates of the Montane Rain Forest on the southern slopes of Volcán Santa Marta. All butterflies were collected as they rested on sunlit leaves.

284. *Thecla ares* Godman & Salvin

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 28 Sept. 1962.

The single specimen was collected as it fed on the blossoms of the composite *Bidens pilosa* var. *bimucronata* in a Pasture. *Thecla ares* has not been recorded from Mexico. The nearest recorded locale is Guatemala (Godman & Salvin, 1879-1901).

285. *Thecla ahola* Hewitson

SPECIMENS: 3 ♀ ♀; 1,900-5,100 feet; 26 May-24 Oct.

Although uncommon, this species nevertheless was collected in a variety of habitats—Lower Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Elfin Woodland. The behavior is characteristic of other members of the tribe.

286. *Thecla gabatha* Hewitson

SPECIMEN: 1 ♀; 0.25 mi. SE Ocozotepec, 1,950 feet, 1 Aug. 1963.

This single specimen of this rare species was collected as it rested on a leaf of an oak tree within the *Pinus-Quercus* Associates of the Deciduous Woodland. The butterfly is unusually dark and possibly represents an endemic subspecies.

287. *Thecla tarpa* Godman & Salvin

SPECIMENS: 2 ♀ ♀; 3 mi. NNW Ocotil Chico, 3,000 feet, 10 June 1963.

This rare species is restricted to the *Liquidambar-Quercus* Associates of the Montane Rain Forest. Both specimens were collected as they rested on leaves along partially shaded trails.

288. *Thecla maeonis* Godman & Salvin

SPECIMEN: 1 ♂; 1.5 mi. NNE Ocotil Chico, 2,700 feet, 11 Feb. 1965.

This species is rare. The male was collected as is fed on the flowers of *Calliandra grandiflora* in the Deciduous Woodland.

289. *Thecla hesperitis* (Butler & Druce)

SPECIMEN: 1 ♀; 2 mi. NE Catemaco 1,100 feet, 23 June 1962.

The single female of this rare species was collected as it fed on the blossoms of *Cordia spinescens* in a Hedgerow.

290. *Thecla denarius* (Butler & Druce)

SPECIMENS: 8 ♂ ♂, 2 ♀ ♀; 1 mi. NE Ocotac Chico, 2,500 feet, 10 March 1965, 3 ♂ ♂, 1 ♀; 12 March 1965, 1 ♂: 1.5 mi. NNW Ocotac Chico, 2,700 feet, 15 June 1965, 2 ♂ ♂, 1 ♀: 2 mi. NNW Ocotac Chico, 2,800 feet, 27 March 1965, 1 ♂.

This species is locally common within the *Pinus-Quercus* Associates of the Deciduous Woodland. All butterflies were collected as they flew about the terminal shoots of the branches of pine trees during the spring months. The butterflies seemed to prefer the relatively high branches of the trees and only rarely did they alight on branches lower than 12 feet of the ground. Although I visited these same locales (and trees) during the summer months, no individuals were observed later than June 15; thus, it appears as if the species is either single or double brooded. The nearest recorded locale is Tabasco (Hoffman, 1940).

291. *Thecla plusios* Godman & Salvin

SPECIMENS: 3 ♂ ♂, 2 ♀ ♀; 1,800-5,000 feet; 15 June-30 Oct.

*Thecla plusios* is locally common and found primarily in the Montane Rain Forest and to a lesser extent in the Montane Thicket and Elfin Woodland. The butterflies prefer sunny glades within the forests.

292. *Thecla clarina* Hewitson

SPECIMENS: 7 ♂ ♂, 5 ♀ ♀; 1,800-3,000 feet; 11 Feb.-23 Oct.

This lycaenid is locally common, being found primarily on the flowers of *Calliandra grandiflora* within the *Pinus-Quercus* Associates of the Deciduous Woodland.

293. *Thecla demonassa* Hewitson

SPECIMENS: 6 ♂ ♂, 2 ♀ ♀; 1,100-2,700 feet; 16 June-14 July.

This small hairstreak is locally common and found principally along Hedgerows and the margins of the Semi-Evergreen Seasonal Forest on the Santa Marta massif.

294. *Thecla tera* Hewitson

SPECIMEN: 1 ♂; 1 mi. SSW Peak Volcán San Martín Tuxtla, 2,300 feet, 27 Aug. 1962.

This species is rare. The single male was collected as it flew approximately five feet above the ground in a sunny glade within the Lower Montane Rain Forest. *Thecla tera* has not been

recorded from Veracruz. The nearest recorded locale is Chiapas (Hoffmann, 1940).

295. *Thecla coronata* Hewitson

SPECIMEN: 1 ♂; 1 mi. SE Sontecomapan, 700 feet, 14 July 1962.

The single male was collected as it rested on a leaf along the margin of the Lower Montane Rain Forest.

296. *Thecla scopas* Godman & Salvin

SPECIMENS: 1 ♂, 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 27 June 1962, 1 ♀: 1 mi. S Coyame, 1,200 feet, 25 June 1962, 1 ♂.

Both specimens of this rare species were collected as they rested on unidentified bushes in Pastures bordering Lago Catemaco.

297. *Thecla mathewi* Hewitson

SPECIMEN: 1 ♂; Ocotál Chico, 1,900 feet, 30 June 1963.

The single male of this rare species was collected as it fed on the blossoms of *Jatropha curcas*, a tree that was growing in the back yard of a local villager in Ocotál Chico.

298. *Thecla politus* Druce

SPECIMEN: 1 ♀; 2 mi. N Ocotál Grande, 3,500 feet, 21 June 1963.

The single specimen was collected as it rested approximately seven feet above the ground on the trunk of a tree that was growing along a trail in a section of Montane Rain Forest. One other butterfly of this species was seen on the same tree trunk but was not collected. *Thecla politus* has not been recorded from Veracruz. Hoffmann (1940) gives the Mexican distribution as the Pacific coast as far north as the state of Colima.

299. *Thecla basalides* (Geyer)

SPECIMENS: 4 ♂♂, 1 ♀; 1,500-2,500 feet; 11 June-12 Aug.

*Thecla basalides* is locally common and found principally in the Deciduous Woodland and the *Pinus-Quercus* Associes. The butterflies were collected most frequently as they fed on the flowers of *Calliandra grandiflora*.

300. *Thecla mulucha* Hewitson

SPECIMEN: 1 ♂; 3 mi. WSW Santiago Tuxtla, 2,700 feet, 30 Aug. 1962.

The single male was collected as it rested on the leaf of a tree along the partially shaded margin of the Semi-Evergreen Seasonal Forest near the peak of Cerro Tuxtla. *Thecla mulucha* has not been recorded from Mexico. The nearest recorded locale is the Polochic Valley of Guatemala (Godman & Salvin, 1879-1901).



301. *Thecla ambrax* Westwood & Hewitson

SPECIMEN: 1 ♂ ; 2 mi. NE Catemaco, 1,100 feet, 28 Aug. 1963.

This species is rare. The single male was collected as it fed on the blossoms of *Cordia spinescens* along a Hedgerow. Clench (personal communication) states that the specimen is different from those of the nominate subspecies in South America. *Thecla ambrax* has not been recorded from Mexico. The nearest recorded locale is Chontales, Nicaragua (Godman & Salvin, 1879-1901).

302. *Thecla dodava* Hewitson

SPECIMEN: 1 ♂ ; 3 mi. NNW Ocotál Chico, 3,300 feet, 30 July 1963.

The single specimen was collected as it rested on a leaf approximately five feet above the ground in a sunny glade within an extensive area of Montane Rain Forest. *Thecla dodava* has not been recorded from Mexico. The nearest recorded locale is Chiriquí, Panamá (Godman & Salvin, 1879-1901).

303. *Thecla kalikimaka* Clench

SPECIMENS: 2 ♂ ♂ ; 2 mi. NNE Catemaco, 1,100 feet, 28 Aug. 1963, 1 ♂ : 0.25 mi. S Ocotál Chico, 1,800 feet, 12 Aug. 1963, 1 ♂ .

This lycaenid is rare. Both specimens were taken as they fed on the blossoms of *Cordia spinescens* in Pastures.

304. *Thecla tamos* Godman & Salvin.

SPECIMENS: 2 ♂ ♂ ; 1 mi. NNW Ocotál Chico, 2,300 feet, 3 July 1963, 1 ♂ : 2 mi. N Ocotál Grande, 3,500 feet, 21 June 1963, 1 ♂ .

This hairstreak is rare. One specimen was collected in the Deciduous Woodland and the other in the Montane Rain Forest on the Santa Marta massif. Both specimens were resting on leaves in sunny glades. *Thecla tamos* has not been recorded from Mexico. The nearest recorded locale is Costa Rica (Godman & Salvin, 1879-1901).

305. *Thecla* nr. *antincus* Felder

SPECIMEN: 1 ♂ ; 1 mi. E Zapopan, 0 feet, 19 May 1965.

The single specimen was collected as it rested on a leaf approximately 12 feet above the ground along the margin of the Swamp Forest along Río Mescalapan. Although the specimen resembles those of *T. antincus*, there are slight differences. In addition, *T. antincus* is known only from South America (Seitz, 1923). Thus, it appears as if the specimen from the Sierra represents an unidentified endemic species.

(To be continued)



## NOTICES

**ADDRESS CHANGE:** After April 1, 1977, the address of the Journal will be: Santa Barbara Museum of Natural History, 2559 Puesta Del Sol Road, Santa Barbara, CA 93105.

**PUBLICATIONS:** Moths of Southern Africa. E. C. G. Pinhey, Tafelberg Publishers Ltd., 28 Wale St., Cape Town, South Africa. Available in U. S. A. from Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, CA 90007. \$35.95.

Butterflies of West Malaysia and Singapore, Vol. 1 and 2. W. A. Fleming, E. W. Classey Limited, Park Road, Faringdon, Berkshire, England. Available in U. S. A. from E. R. S. (above). \$47.00 set.

**ADDITIONAL PUBLICATIONS:** Revised Catalogue of the African SpHINGIDAE (Lepidoptera) with Descriptions of the East African Species. R. H. Carcasson, E. W. Classey Ltd., Park Road, Faringdon, Oxon. SN7 7DR, England. Available in North America from Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, CA 90007. \$11.95.

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# THE JOURNAL OF RESEARCH ON THE LEPIDOPTERA

Volume 15

Number 3

September, 1976

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THE EARLY STAGES OF  
*LEUCANELLA MEMUSAE*  
SSP. *GARDINERI* LEMAIRE  
(SATURNIIDAE)

BRIAN O. C. GARDINER

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SYNOPSIS

This paper describes the rearing of, and illustrates the larva of, a newly described subspecies of *Leucanella memusae* which differs in colour from, and in pupation habits from, the type species. A summary is given of the chief adult differences.

INTRODUCTION

In a recent revision of the genus *Automeris* Hubner, Lemaire (1971; 1973a, b.) has rectified and clarified the position of species in this conglomerate genus. Amongst those species transferred to the new genus *Leucanella* Lemaire, is *memusae* Walker which now consists of the type, *L. m. memusae* (Walker) and a new subspecies *L. m. gardineri* Lemaire, which was named from adults reared by me from eggs shipped to England by Sr. Fritz Plaumann who obtained them in Nova Teutonia, Santa Catarina, Brazil. Eggs of the type species *memusae* were obtained from a local dealer. The type species has been known and bred in England for many years. (Crotch, 1956).

*LEUCANELLA MEMUSAE MEMUSAE*

The type species is already well known and described. See for instance Crotch, 1956. The present observations confirmed those described by Crotch except that the early stages of the larvae were fed on Laburnum (*Laburnum anagyroides*) the later stages on Privet (*Ligustrum ovalifolium*). The duration of the various



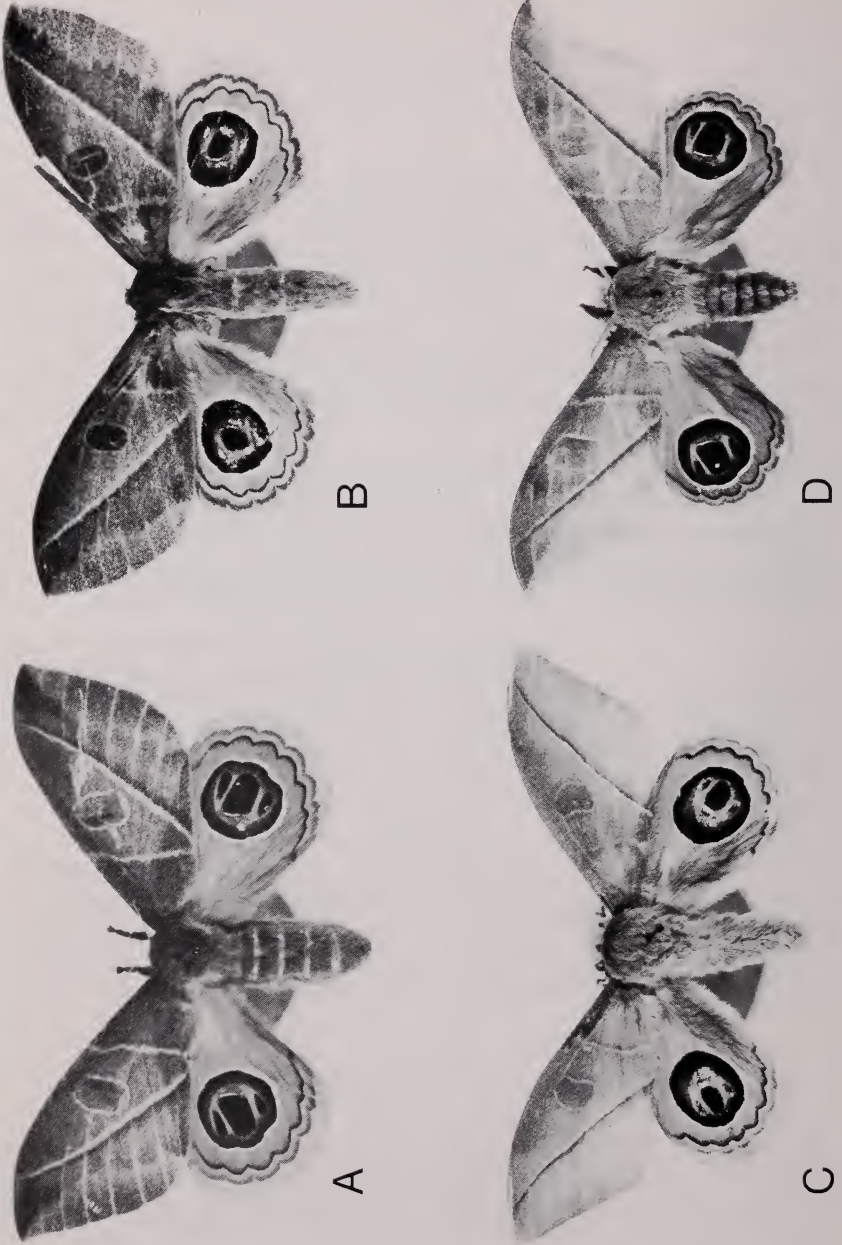


Fig. 1.—Adults of *Automeris memusae*. A. ssp. *gardineri*, female, D, male.  
B. ssp. *memusae* female, C, male.

stages are given in Table 1. It is only necessary to emphasize here that the pupa was formed above ground, usually in 'litter' on the cage floor and neither in rolled fresh leaf of the food-plant, (as is usual with several *Automeris* species), nor in the specialized condition required by subspecies *gardineri* as described below.

### LEUCANELLA MEMUSAE GARDINERI

The chief differences in the adult between this sub-species and the type is set out in Table 2. In addition to those shown, there is a subtle difference in coloration and the subspecies generally has a more falcate wing-tip in the male, and all the markings are clear, distinct and more prominent. Fig. 1 shows the adults for comparison. The length of the various early stages is given in Table 1, from which it can be seen they are essentially similar to those of the type species. The rather longer period spent in the first instar is not considered significant as some second brood larvae took only 9 days.

The larvae were reared at 20-25°C under a constant photoperiod of 18 hours per day, the natural daylength being extended by fluorescent lighting. Young larvae were kept in plastic boxes, larger ones in wooden framed cages covered in white terylene netting and with glass fronts.

The most striking difference between the larvae of the subspecies and the type was in the stinging spines. In the type they are uniformly canary yellow in colour. In the subspecies they are only yellow on the six central segments. On the three anterior and posterior segments they are white except for a few lateral yellow spines. The larvae are shown in Fig. 2. The newly hatched larvae were offered a choice of Laburnum or Privet. All preferred to feed on Privet and this was used and accepted throughout their life. When the time came to pupate the larvae wandered restlessly round and round the cage, although they were supplied with a plentiful stock of leaves, and the cage was covered in peat overlaid with moss, all standard pupation sites for *Automeris* species known to me and providing suitable pupation sites for type *memusae*. In this wandering they were reminiscent of *Dirphia curitiba* Draudt and it appeared they desired a similar pupation site (Gardiner, 1974). This was therefore provided, a half pound tin partly full of moist peat overlaid with a layer of moss and a lid to give total darkness.

Under these conditions all the larvae were successfully pupated, this taking place in a flimsy cocoon under the moss on the surface of the peat.

Most of the resulting adults were used for physiological experiments, but two pairings were obtained without difficulty the moths being in the same type of cages and under the same conditions as the larvae had been kept at. Nearly all the eggs laid hatched and it was noticed that the larvae only partly ate their eggshells. These F.1 larvae readily started to feed on Privet, but of the two batches obtained one lot died just when ready to pupate and the second when half grown. The mortality resembled the disease of larvae caused by nuclear polyhedrosis virus and samples were submitted to the Division of Invertebrate Pathology, Berkeley, California, but they were unable to give an opinion. The author, from his own experience, is however convinced that this is a clear case of transovarial transmission of virus disease, there being no other diseased stock in culture at the time, and it is unlikely (but perhaps not impossible) for a Neotropical species, not represented in the northern hemisphere, to catch a Palearctic virus.

TABLE 1.

The length in days of various stages in the type and subspecies of *Leucanella memusae*.

Stage	<i>m. memusae</i>	<i>m. gardineri</i>
Egg	18	20
Instar 1	8	14
2	9	10
3	10	11
4	6	6
5	8	12
6	11 - 14	8 - 13
7	14 - 24	12 - 22
Pupa	150 - 180	120 - 150

TABLE 2.

Numerical points of difference between type *memusae* and subspecies *gardineri* (after Lemaire, 1973b).

		<i>L. m. memusae</i>	<i>L. m. gardineri</i>
Wingspan	♂	59 - 71 mm	75 - 78 mm
	♀	60 - 84 mm	77 - 89 mm
Antennae	♂	29 segments	32 segments
	♀	31 segments	32 segments
Diameter of ocellus	♂	8 mm	11 - 12 mm
	♀	10 - 12 mm	14 - 15 mm

## COVER

Fig. 2.—Larva of *Automeris memusae* ssp. *gardineri* feeding on Privet.

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SUPPLEMENTARY NOTES ON THE  
DISTRIBUTION OF *EPARGYREUS CLARUS*  
IN SOUTHERN CALIFORNIA (HESPERIIDAE)

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*EPARGYREUS CLARUS* (CRAMER) HAS BEEN RECORDED RECENTLY in southern California from only the San Bernardino Mountains and "San Diego County mountains" (Emmel & Emmel, 1973), and the Santa Rosa Mountains (J. Emmel in Langston, 1975). However, recent captures and the discoveries of museum specimens and old literature records have filled in the gaps between the many well known northern California localities and the few well known southern California localities.

On the afternoon of 15 June 1975, while hiking up Santa Barbara Canyon towards Malduce Peak on U.S.F.S. trail 25W02 (elevation about 3600 feet; 16 air miles SSE of New Cuyama), Los Padres National Forest, Santa Barbara County, California, Richard C. Priestaf and the author caught three specimens of *E. clarus* along the stream. The record of a recent capture by Phil McNally was provided by Larry J. Orsak: 1 July 1973, approximately 2.6 miles from Highway 74 on U.S.F.S. road 3S04 (elevation 3200 feet), Santa Ana Mountains, Orange County, California.

The following specimens in the collection of the Santa Barbara Museum of Natural History represent further unpublished range extensions: SAN LUIS OBISPO COUNTY: Lopez Canyon, 1954 (R. Hart), 1956 (R. Taylor); Oak Creek Canyon (near San Miguel; now called Mahoney Canyon), 26 May 1960 (R. Taylor); VENTURA COUNTY: Sespe Gorge, 30 June 1963 (T. P. Webster III); "Piru Creek", 22 June 1965 (T. P. Webster III); "Ridge, Piru", 22 June 1965 (T. P. Webster III). The "Piru" specimens are probably from the upper section of Piru Creek in the mountainous area of Los Padres National Forest, not in the area of the town of Piru (Webster, Pers. Comm.).

The following old literature records have been found: LOS



ANGELES COUNTY: Mint Canyon, 25 April 1927 (Gunder, 1930); Westlake Park, 12 September 1920 (Gunder, 1930); Upper Santa Monica Canyon, July (Rivers, 1905); SAN DIEGO COUNTY: City of San Diego and Henshaw Dam (Wright, 1930).

Thus, the range of *E. clarus* extends throughout the mountains of southern California. These data give additional proof that many features of this state's Lepidopterous fauna still remain to be discovered.

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## BOOK REVIEW

British Tortricoid Moths, Cochylidae and Tortricidae: Tortricinae, by J. D. Bradley, W. G. Tremewan, and Arthur Smith. 1973. The Ray Society, c/o British Museum (Natural History), London. viii + 251 p., 51 fig., 47 pl. (pl. 22-47 in color). Price: £14.50 (\$34.80 U.S.).

Sumptuous is a good word to describe this first volume of a two volume faunal review of the British tortricoid moths. The intended audience is stated to be the non-specialist, with the book emphasizing wing coloration and biologies. This first volume covers 48 species of Cochylidae (= Phaloniidae), followed by the tortricid subfamily Tortricinae (94 spp.). The second volume will cover the remaining Olethreutinae (227 spp.). Every species validly known to occur in England, Scotland, and Ireland is illustrated with color figures very accurately painted by Arthur Smith (Cochylidae and 1 sp. of Tortricinae) and Brian Hargreaves (most Tortricinae). Some tortricids have so many morphs that in three cases a full plate is devoted to one species, making the book exemplary in its illustration of tortricid polymorphism. A few species are included in the text but not illustrated, as they are stated to be strays or short-lived introductions. Virtually all of the 142 included species are widespread in Europe and many occur throughout the Palearctic region, often as far as Japan. Of the included species, 23% are also found in North America: 5 Cochylidae and 27 Tortricinae (1 in Hawaii), some being of economic importance as well.

For all the good points, it is evident that little effort was made to economize: there is a gold embossed imprint on the front cover; volume size is large (quarto) and the print size is also large; the number of color plates is excessive for the size of the British fauna; and the halftones of larval host plant damage are widely spaced per plate. These items are marvelous for the bibliophile, but greatly increase the cost of the volume when ostensibly the intended audience is the British amateur collector: perhaps British amateurs have no problem with funds for books such as this one. The color reproduction of the adult moths is very well done, as is usual for the Curwen Press. Some of the figures are small, however, and could have benefited from added enlargement. An additional annoyance is the lack of text page

notations to the figure captions. The organization of the color figures into plates leaves much to be desired, since this relates so directly to the excessive cost of the work (increased in 1975 from the original price). Many plates have a great amount of empty space between figures. The number of color plates could have been reduced by 50% had the figures been arranged more closely together. With reduced plate number and smaller type, the authors undoubtedly could have achieved their stated original intention of encompassing the whole British tortricoid fauna in only one volume. It has long been my belief that the expense of color illustration can be eliminated by using sharp, enlarged (about 2 x 2 in.) black and white photographs (close cropped) of the left or right pair of wings. One then has the increased detail of enlargement of small species and the reduction in cost to the whole volume: color can be described quite well in the text.

Overall, the book is an exceptional manual for students of British and European tortricoids. The authors preface the species discussions with 20 pages of text on adults and immature stages, and with notes on collecting and techniques of morphological studies. There is a key to higher taxa, but none for the genera or species. There is a handy checklist of species and major synonyms, but the dates of original description of the species are not given in the book. Descriptions of adults are extensive and fully discuss variations of polymorphic species, but one misses descriptions of genera or even generic discussions. The text is otherwise authoritative and apparently free of major errors, covering the subjects in lucid, precise scientific prose. Genitalia are rarely mentioned in the descriptions, the reader being referred to the illustrations in Pierce and Metcalfe (1922, Genitalia Tort. Brit. Isles). This arrangement is adequate but many of the figures of Pierce and Metcalfe are so small that critical features are obscured, sometimes even absent. The classification used by Bradley and Tremewan follows the present understanding of the tortricoids as based on genitalic morphology and follows the arrangement and higher groupings of the recently revised British checklist (Kloet & Hincks, 1972), except that tribal categories have been added. The halftone plates of larval damage to host plants are a welcome addition to the work, but some figures do not have much visible larval damage evident. All species (excluding strays) are provided with descriptions of immature stages (usually including the egg and pupa, as well as the larva), biologies, and host data, leaving out only one

tortricid with unknown biology and one other tortricid for which the larva is unknown. If only we had this kind of biological knowledge for North American tortricoids. Distributions are given in full, but without the use of maps.

Since the book has valuable biological data and much of the Palearctic fauna is so closely related to the Nearctic fauna (as noted, 32 of the included species also occur in North America), I would recommend this book to those American students of the Tortricoidea who can afford it. It can be of value for North American economic entomologists as a compendium of what is known of the British fauna. For British lepidopterists it is unquestionably a magnificent summary of current knowledge of the British tortricoids, both biologically and taxonomically, and well worth investing in.

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## A NOTE ON *OENEIS JUTTA HARPERI*,

ITS AUTHOR AND DATE OF PUBLICATION  
(SATYRIDAE)

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A FEW YEARS AGO JOHN H. MASTERS PUBLISHED A PAPER (1969, 3(2):23-24) entitled, "An unusual nomenclatorial problem regarding *Oeneis jutta*, (Lepidoptera: Satyridae)" in which he mentioned the fact that "*harperi*", which Wyatt (1965, 50: 69) cited while describing *Oe. j. chermocki* had never been published by Chermock [and Chermock] which is the fact. Masters suggested that Wyatt was the author of *harperi* and that an arrangement in check list order for this name, insofar as material, should read as follows:

"*Oe. j. ridingiana* Cher. & Cher. 1940

= *harperi* Wyatt 1965 (*nec* Chermock)"

thus recognizing Wyatt's publication of *harperi* as valid, but not considering whether he himself had not thereby published this name in 1969 by placing *harperi* in the synonymy of *ridingiana*. The description by Wyatt, in German, is as follows:

" . . . Die neue, grosse und hell gezeichnete Rasse steht *harperi* CHERMOCK aus dem subarktischen Manitoba und von der Hudsons Bay zunächst, ist jedoch in beiden Geschlechtern grösser und heller gezeichnet."

which is translated:

" . . . The new, large and brightly marked race ranks next to *harperi* CHERMOCK from the subarctic area of Manitoba and the Hudson Bay and yet in both species is larger and more brightly marked."

Masters claims (1969, p. 23) that Chermock and Chermock's draft ms. description of this name reads essentially as follows:

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"Expanse: male 42 mm.; female 45 mm. "On the upperside of the male, the ocelli are small surrounded by narrow rings of light rusty orange. "The ground color is dark brown, approaching black with a copper iridescence. "The underside is extremely dark with only a faint mesial band. "The gray striation is faint. "Female with larger ocelli than the males but with similar under surface. "Holotype and Allotype: Gillam, Manitoba; 24 Paratypes, Gillam; 6 Churchill."

This is not a translation of Wyatt's description of *harperi* as might appear at first sight. It seems to be the language, more or less, of Chermock's unpublished *ms.* There are half quotation marks before each sentence, as given above, and it bears little or no resemblance to Wyatt's published description. No holotype, allotype and paratypes are mentioned by Wyatt for *harperi*.

Size and shades of color are but feeble grounds upon which to base a new name. The former may be influenced by the amount of food consumed by the larva and the latter by the age of the specimen when captured and its subsequent exposure to light. Fortunately, we are not obliged to determine whether a description reading, "larger and more brilliant than" is a sufficient indication because, as shown below, *harperi* as published by Wyatt is invalid anyway.

It is believed that parts of Wyatt's paper describing *chermocki* as published was transposed by someone, possibly the editor or printer, because the information concerning the types of *chermocki* are separated by three paragraphs from the paratypes and it is suspected that the second paragraph on page 70, which is concerned with descriptions of the male and female holotype and allotype should be united with the description of the paratypes by transferring the paragraphs relating to them so that holotype and allotype are followed by the paragraphs dealing with the paratypes.

To summarize this problem and its solution: The name *harperi* by itself and not in combination with any generic name was first used by Wyatt (1965, p. 70). He ascribed it to Chermock, believing that it had been published by Frank H. Chermock, or Chermock and Chermock. But the Code (Art. 11(g) (ii)) provides that, "A species-group name [*harperi*] must be published in combination with a genus group name [*Oeneis*] . . ." (*italics mine*), i.e., as *Oeneis harperi* or *Oeneis jutta harperi*

which was not done by Wyatt. "Combination" is not defined in the glossary of the Code (1964), but a binomen is defined (p. 148) as "The combination of a generic and a specific name which together constitute the scientific name of a species." Certainly *harperi* standing entirely by itself in the middle of a sentence is not a combination constituting an indication (Code, 1964, Art. 16(a)). This, quite definitely, is not a compliance with the Code rule quoted above and, hence, this publication by Wyatt of *harperi* is invalid.

The next use of *harperi* was by Masters (1969, pp. 23-24). It would appear, at first glance, that this time the name could be ascribed to Masters but, again, there is a defect in its publication in that, although he used the name as a trinomial (see Code, Art. 6) by writing "*Oeneis jutta* (Hubner) . . . *j.ridingiana* Cher. & Cher. = *harperi*" and gave a description thereof, he published it in the synonymy of *ridingiana*. Therefore, this publication is also invalid under the Code (Art. 11(d)).

To give the name the validity that I believe it should have, I hereby publish it as

*Oeneis jutta harperi* ssp. n.

and refer to the papers herein cited for bibliographical references. The types therein named are apparently in the collection of Paul W. Chermock, second son of Frank H. Chermock. The type locality is fixed as Gillam, northern Manitoba, due south of Churchill.

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TYPE LOCALITY FOR  
*CALOSATURNIA WALTERORUM* JOHNSON  
(SATURNIIDAE)

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THE TYPE LOCALITY for *Calosaturnia walterorum* is fixed by Johnson (1940) to be Santiago Canyon, Orange County, California. Santiago Canyon, however, stretches for approximately ten miles and ranges in elevation from 1000 feet to over 4600 feet. It seems desirable to fix the type locality more specifically, to eliminate any possible confusion as to where the type was collected. Mr. Erich Walter, who captured the holotype, marked the location of its capture on a 1954 edition of the Santiago Peak, California, Geological Survey Quadrangle Map. Map coordinates for the type locality are: <sup>4</sup>44300 meters East, <sup>37</sup>29000 meters North. The holotype was captured along Santiago Creek at the junction of the first stream that branches North (East of Modjeska Canyon), on March 15, 1925. Altitude is 1600  $\pm$  20 feet. The type locality is in the Cleveland National Forest.

The early stages and life history of this very rare Saturniid have been described elsewhere (Sala and Hogue, 1958).

I wish to thank Mr. Erich Walter (Anaheim, California) for his help in preparing this manuscript.

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## INVESTIGATION OF SELECTED SPECIES OF THE GENUS *ORGYIA*

(LYMANTRIIDAE) USING ISOELECTROFOCUSING  
IN THIN LAYER POLYACRYLAMIDE GEL.

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### ABSTRACT

Egg-protein patterns from four selected species representing the genus *Orgyia* were obtained by electrofocusing in thin layer polyacrylamide gel. The patterns were specific and reproducible. The usefulness of this method in analysis of closely related species was suggested.

### INTRODUCTION

*Orgyia wardi* from Nova Scotia was described by Riotte (1971) as a distinct species from *Orgyia leucostigma* (J. E. Smith).

Both species occur sympatrically and even when they occupy the same tree there was no evidence of hybridizing. Initial separation of the two species was based on morphological differences of the eggs, the larvae, the pupae and the genitalia of both sexes, which were illustrated by Riotte (1971 and 1974). In the latter publication he further presented morphological characters of the larval mandibles, chaetotaxy of thoracic legs, female genitalia and electronmicrographs of the male genitalia.

Riotte (1973) also described *Orgyia definita rindgei* from New Mexico as new and a subspecies of the eastern *Orgyia definita* Packard. Subsequently this description, which was based upon a striking similarity of the larvae, was revised (Riotte, 1974), and it was suggested that *O. rindgei* could be a species *suo iure*. Riotte (1973) also indicated that the "final

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decision on the taxonomy of these populations will have to wait until detailed biological comparisons are complete."

It is apparent from the present study that egg protein patterns of *O. definita* and *O. rindgei* suggest that they are separate species, as are *O. wardi* and *O. leucostigma*. Colour illustrations of the larvae are also presented for comparison.

## MATERIALS AND METHODS

Eggs of *O. definita*, *leucostigma*, *rindgei* and *wardi* were collected from various places in North America in the spring, summer and winter of 1973. The egg masses were stored at  $-8^{\circ}\text{C}$  until ready for analysis. Thirty-five eggs were gently removed from the eggmass of each species using fine forceps under a dissecting microscope. The eggs were washed in distilled water and were homogenized in  $200\mu\text{l}$  of 0.1 M Tris-HCl buffer pH 7.1 as described by Whitt (1970) using a small glass homogenizer. The homogenate was centrifuged in a Beckman 152 Microfuge at 8000 g for five minutes. The supernatant fraction was stored at  $-30^{\circ}\text{C}$  until subjected to electrofocusing in thin layer polyacrylamide gel using the LKB 2117 Multiphor. Detailed procedure for operating the Multiphor is already described in the LKB publication, Instruction Manual (1-2117-E 01), hence only modifications of the procedure such as the composition of the acrylamide gel formula will be described here. The gel was prepared by dissolving 4.25 g acrylamide and 0.20 g N, N'-Methylenebisacrylamide in 55 ml distilled water. The solution was filtered through Whatman no. 1 paper. Then 3.0 g sucrose,  $15\mu\text{l}$  TMED (Gelling primer), 2 ml of 0.004% riboflavin, 20 mg of ammonium persulfate (gelling accelerator) and 3 ml of ampholine pH 3.5-10 (carrier ampholytes) were added into the solution. The unpolymerized acrylamide gel solution was poured into the gel moulding. After polymerization the gel was stored overnight in a container covered with a thin polyethylene sheet or SARAN Wrap at  $4^{\circ}\text{C}$ . Before each run the gel was brought to room temperature and the sample was thawed. Using Eppendorf pipet  $40\mu\text{l}$  of the sample was transferred onto Whatman 3MM paper ( $3\times 3\times 1\text{ mm}$ ) placed on the cathodic region of the gel. Duplicate aliquots of each homogenate were used for the determination of the protein patterns. The thin layer gel electrofocusing was run at  $10^{\circ}\text{C}$  for a total of 2.5 hours. The first 1.5 hours, constant current (25mA) was applied while the voltage



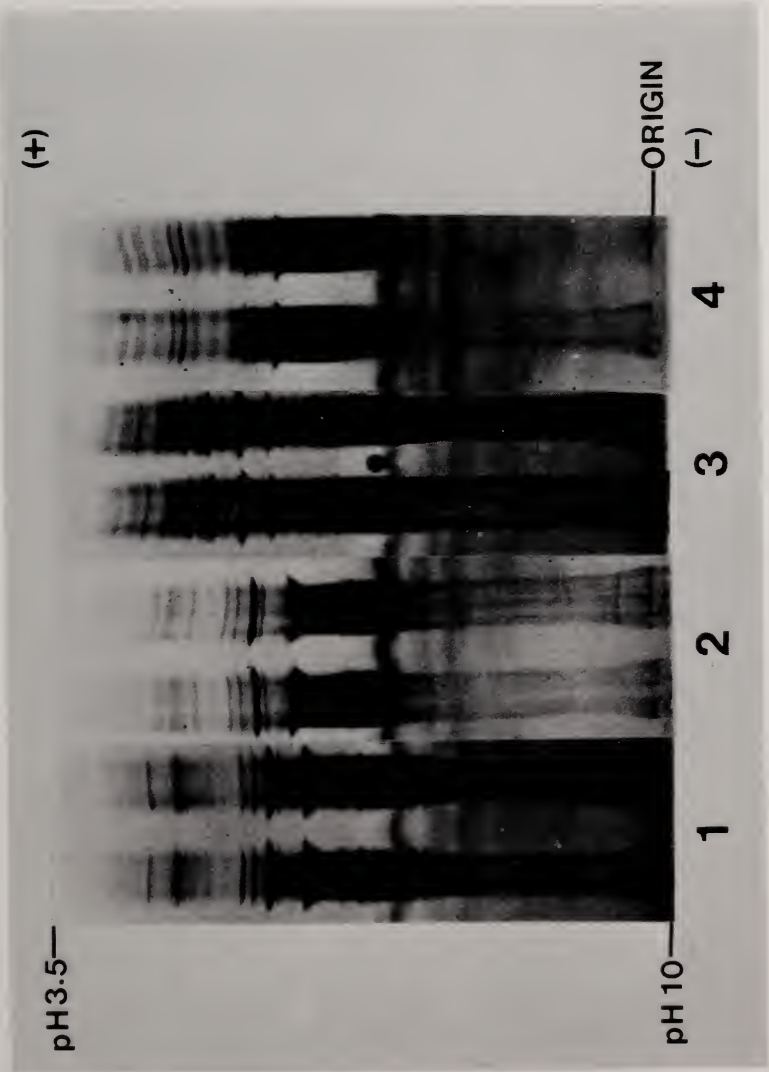


Fig. 1.—Electrofocusing patterns of soluble proteins from the eggs of:  
1. *O. leucostigma*, 2. *O. wardi*, 3. *O. definita*, 4. *O. rindgei*.



Fig. 2.—Color illustrations of the larvae of: 1. *O. leucostigma*.

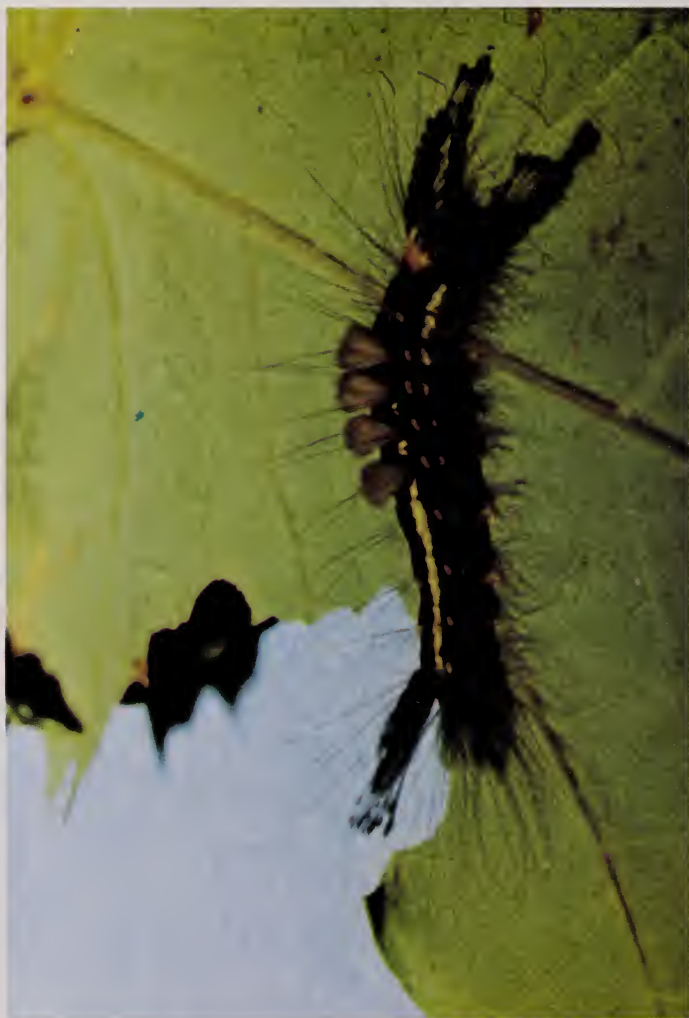
was allowed to increase from 70 to 800 volts. Then the run was changed to constant voltage (at 800 V) for the remaining one hour and the current was allowed to drop from 25 to 17 mA until the end of the run. Subsequently the gel was removed and stained and destained for general protein using Coomassie Brilliant Blue R-250 as described by Karlsson et al. (1973). After twenty-four hours the bands were fully developed and the stained gel was photographed by reflected and transmitted light.

The larvae had been obtained from the same stock of eggs which were allowed to hatch in the laboratory at 22C.

## RESULTS AND DISCUSSION

Electrophoretic techniques have been used by many investigators for analysis of protein patterns for taxonomic purposes in insects (Stephen 1958, 1961; van Sande and Karcher 1960; Marty and Zolta 1968). In all cases the proteins of the hemolymph were used. However, hemolymph proteins are subject to variation because of differences in ontogenetic stage and environmental conditions of the insect donors (Laufer 1964 and Kock 1968). Salkeld (1969) in her studies of several insect taxa described and suggested the usefulness of newly laid eggs for determination of protein patterns using electrophoresis because the protein composition of such eggs is stable prior to differentiation of the embryo. Hence, in this investigation only newly laid eggs were subjected to the electrofocusing in thin layer polyacrylamide gel. This technique was chosen because it is easy to standardize and the proteins are separated according to a well defined physico-chemical constant, the isoelectric point (pI). Hence the protein zones are sharp and reproducible (Karlsson et al., 1974).

Fig. 1 indicates that there is an apparent distinction between the protein patterns of *O. leucostigma* (1) from that of *O. wardi* (2), both in the cathodic and anodic regions. The anodic protein bands of *O. definita* (3) and *O. rindgei* (4) also suggest specific differences between the two species. The investigation suggests that a high degree of species specificity and a good resolution of protein bands of insect eggs can be accomplished using the electrofocusing in thin layer polyacrylamide gel. Biochemical techniques such as this one can definitely complement and confirm other biological data in the field of analytical systematics.



2. *O. wardi*.



3. *O. defnita*.



Fig. 2 illustrates the differences in coloration of the larvae of *Orgyia* species under investigation. The color dissimilarities of the larvae support the results of the egg protein determination using electrofocusing technique and vice versa.

### ACKNOWLEDGEMENT

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## TRIBE Plebejini

306. *Hemiargus (Hemiargus) ceraunus zachaeina* (Butler & Druce)

SPECIMENS: 37 ♂♂, 12 ♀♀; 0-2,300 feet; 6 June-15 Aug.

This blue is abundant in most open, sunny areas throughout most of the Sierra irrespective of plant formation. The butterflies fly relatively slowly, close to the ground, and visit flowers—particularly *Oxalis neaeii*, an abundant plant in the oak and pine-oak forests—and mud puddles very frequently.

307. *Hemiargus (Echinargus) huntingtoni hannoides* Clench

SPECIMENS: 15 ♂♂, 5 ♀♀; 350-2,350 feet; 6 June-4 Oct.

This blue is common only in the Savanna, Deciduous Woodland, and the *Pinus-Quercus* Associates. The butterflies were collected most frequently as they flew relatively slowly and close to the ground in partially shaded, grassy glades. Thus, *H. huntingtoni hannoides* is less widely distributed than is the sibling *H. ceraunus zachaeina* and only partially sympatric with it.

308. *Hemiargus (Echinargus) isola isola* (Reakirt)

SPECIMEN: 1 ♂; Ocotal Chico, 1,900 feet, 5 Feb. 1965.

Only one specimen of this species was collected. The butterfly was found along a sunny trail within the *Pinus-Quercus* Associates of the Deciduous Woodland. Although the data indicate that the species is rare, the conclusion may be erroneous for it is possible that numerous individuals were overlooked because of the species' close similarity to both *H. ceraunus zachaeina* and *H. huntingtoni hannoides*.

309. *Everes comyntas comyntas* (Godart)

SPECIMENS: 10 ♂♂, 8 ♀♀; 1,100-2,300 feet; 6 Feb.-23 Oct.

The eastern tailed blue is common to abundant in most open, sunny areas throughout the Sierra. The butterflies fly relatively slowly, close to the ground, and are attracted to the flowers of a variety of plant species as well as mud puddles.

310. *Leptotes cassius striata* (Edwards)

SPECIMENS: 11 ♂♂, 10 ♀♀; 1,100-5,100 feet; 11 Feb.-7 Sept.

The cassius blue is abundant in most open, sunny areas. The butterflies are attracted to flowers and mud puddles. The flight is relatively slow and within two feet of the ground. Within the Catemaco Basin, I observed females ovipositing on *Crotalaria vitellina*, a common plant in fields and pastures.

311. *Celastrina argiolus gozora* (Boisduval)

SPECIMENS: 7 ♂♂, 1 ♀; 1,800-5,400 feet; 24 March-25 Aug.

The spring azure is common on the peaks of the two highest volcanoes. The butterflies frequently were seen as they flew above the ridges and as they rested on leaves in the canopy of the Elfin Woodland. The flight is relatively weak but moderate in velocity.

FAMILY RIODINIDAE  
SUBFAMILY Euselasiinae

## TRIBE Euselasiini

312. *Euselasia sergia* (Godman & Salvin)

SPECIMENS: 2 ♂♂; Ocotal Grande, 1,800 feet, 15 May 1965, 1 ♂: Ocotal Chico, 1,900 feet, 17 April 1965, 1 ♂.

This metalmark is rare. Both specimens were collected along the margins of the Semi-Evergreen Seasonal Forest on the southern slopes of Volcán Santa Marta. The behavior of this species is typical of most members in the family: first, a fast erratic flight that usually is of relatively short duration; and secondly, a resting position usually on the undersurfaces of leaves with the wings held in a horizontal position.

313. *Euselasia hieronymia* (Godman & Salvin)

SPECIMENS: 6 ♂♂, 3 ♀♀; 1,100-4,300 feet; 24 March-30 Oct.

*Euselasia hieronymia* is locally common. Most butterflies were collected in the *Liquidambar-Quercus* Associates of the Montane Rain Forest, Semi-Evergreen Seasonal Forest, and Montane Rain Forest on the Santa Marta massif above the villages of Ocotal Chico and Ocotal Grande. The behavior is similar to that of *E. sergia*.

314. *Euselasia cheles aurantiaca* (Godman & Salvin)

SPECIMENS: 11 ♂♂, 2 ♀♀; 2,300-5,400 feet; 24 March-25 Aug.

This large *Euselasia* is locally common in the Montane Thicket and Elfin Woodland on the two highest volcanoes. The flight is extremely erratic and usually in excess of six feet of the ground.



315. *Euselasia cataleuca* (Felder)

SPECIMENS: 6 ♂♂, 1 ♀; 1,150-3,000 feet; 1 Sept.-30 Oct.

This species is uncommon, local, and seasonal. Most butterflies were collected along wide, sunny trails within the Lower Montane Rain Forest on the southern slopes of Volcán San Martín Tuxtla. The species seems to prefer low, damp areas, particularly where *Boehmeria* sp. is growing. The flight is extremely erratic and usually in excess of five feet of the ground.

316. *Euselasia pusilla* (Felder)

SPECIMENS: 1 ♂, 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 22 July 1962, 1 ♀; 30 Sept. 1962, 1 ♂.

Both individuals of this rare species were collected in a coffee finca within the Semi-Evergreen Seasonal Forest in the vicinity of Lago Catemaco.

317. *Euselasia eubule* (Felder)

SPECIMEN: 1 ♂; 8 mi. SSE Catemaco, 1,900 feet, 13 Nov. 1962.

The single specimen was collected in a partially shaded section of Semi-Evergreen Seasonal Forest.

## SUBFAMILY Riodininae

## TRIBE Riodinini

318. *Hades noctula* Westwood

SPECIMENS: 1 ♂, 3 ♀♀; 1,800-2,400 feet; 13 March-8 June.

This riodinid is uncommon. All specimens were collected along streams in ravines within the Semi-Evergreen Seasonal Forest on the southern slopes of Volcán Santa Marta. The flight is very slow, weak, and usually between four and eight feet of the ground.

319. *Perophtalma tullius lasius* Stichel

SPECIMEN: 1 ♂; 0.5 mi. N Ocotal Grande, 2,100 feet, 21 June 1963.

The single specimen of this rare species was collected as it rested on the uppersurface of a leaf along a shaded trail within the *Liquidambar-Quercus* Associates of the Montane Rain Forest. *Perophtalma tullius lasius* has not been recorded from Veracruz. The nearest recorded locale is Chiapas (Hoffmann, 1940).

320. *Leucochimona philemon nivalis* (Godman & Salvin)

SPECIMENS: 3 ♂♂, 4 ♀♀; 800-2,100 feet; 10-29 July.

This white metalmark is uncommon and is found primarily in

the interiors of the Lower Montane Rain Forest. The butterflies were netted most frequently as they rested on the ground with the wings held in a horizontal position. The flight is extremely slow, weak, and usually within two or three feet of the ground.

321. *Leucochimona vestalis vestalis* (Bates)

SPECIMENS: 6 ♀ ♀; 0.5 mi. NNE Ocotál Chico, 2,200 feet, 1 July 1963, 1 ♀; 2 mi. SSW Peak Volcán San Martín Tuxtla, 2,200 feet, 24 July 1962, 1 ♀; 5 mi. E Cuetzalapan, 2,450 feet, 18 Aug. 1962, 1 ♀; 2,500 feet, 4 Sept. 1962, 1 ♀; S slope Volcán San Martín Tuxtla, 4,300 feet, 25 Aug. 1962, 1 ♀; 4,750 feet, 25 Aug. 1962, 1 ♀.

This species is uncommon, being found mainly in the interiors of the Montane Rain Forest and the Lower Montane Rain Forest (only at the upper limits). This species has not been recorded from the state. The nearest recorded locale is Chiapas (Hoffmann, 1940).

322. *Mesosemia tetrica* Stichel

SPECIMENS: 11 ♂ ♂, 4 ♀ ♀; 500-2,300 feet; 30 June-23 Oct.

This metalmark is locally common and is found principally in disturbed areas of Semi-Evergreen Seasonal Forest. The butterflies usually were found in very restricted areas (usually along trails) within the forests and so the species apparently is colonial. The flight is slower and less erratic than that of most species of riodinids but similar to that of the small species of satyrids (*Euptychia* spp.). The butterflies rest on the undersurfaces of leaves with the wings held in a horizontal position and on the uppersurfaces of leaves with the wings held at a 45° angle.

323. *Mesosemia gaudiolus* Bates

SPECIMENS: 20 ♂ ♂, 2 ♀ ♀; 500-3,000 feet; 1 March-19 Oct.

*Mesosemia gaudiolus* is locally common and found primarily in the relatively low and damp areas of the Lower Montane Rain Forest and Montane Rain Forest. The species appears to be colonial although the colonies are less restricted than those of *M. tetrica*. The resting behavior is identical with that of *M. tetrica*.

324. *Eurybia lycisca* Westwood

SPECIMENS: 2 ♂ ♂; 4.5 mi. ESE Sontecomapan, 75 feet, 6 Aug. 1962.

Both specimens of this rare species were collected at 6:30 P.M. in a dark, dense patch of Swamp Forest bordering Río Yougualtajapan. The butterflies were chasing each other approximately two feet above the ground.

325. *Cremna umbra* (Boisduval)

SPECIMENS: 6 ♂ ♂, 2 ♀ ♀; 1,100-2,900 feet; 24 June-20 Nov.

*Cremna umbra* is uncommon and local. Most butterflies were collected as they rested on the undersurfaces of leaves along the margins of Hedgerows and the Semi-Evergreen Seasonal Forest.

326. *Ancylusis jurgensenii* (Saunders)

SPECIMEN: 1 ♂; 1 mi. E Zapoapan, 0 feet, 19 May 1965.

Only one specimen of this large riodinid was collected. The butterfly was found in a Pasture.

327. *Rhetus arcus thia* (Morisse)

SPECIMENS: 4 ♂ ♂, 1 ♀; 1,100-1,800 feet; 17 July-16 Sept.

This tailed metalmark is uncommon, being found primarily along the margins of the Semi-Evergreen Seasonal Forest in the vicinity of Lago Catemaco.

328. *Isapis agyrtus hera* Godman & Salvin

SPECIMEN: 1 ♂; 1 mi. ENE Ocotal Chico, 1,700 feet, 17 June 1965.

This little butterfly is rare and was collected along a thicket within the *Pinus-Quercus* Associates of the Deciduous Woodland. The species has not been recorded from Veracruz. The nearest recorded locale is Chiapas (Godman & Salvin, 1879-1901).

329. *Nothome eumeus diadema* Stichel

SPECIMEN: 1 ♂; 9 mi. SSE Catemaco, 1,800 feet, 23 June 1962.

The single specimen was collected as it rested on the under-surface of a leaf of a coffee plant in a coffee finca located in the Semi-Evergreen Seasonal Forest.

330. *Calephelis fulmen* (Stichel)

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet; 12 Aug. 1962.

This little metalmark is rare (although numerous other individuals may have been overlooked because of the species' similarity to other species of *Calephelis*). The butterfly was collected in a Pasture bordering Lago Catemaco. According to McAlpine (personal communication), the species has an extensive distribution through Mexico and Central America.

331. *Calephelis* sp. 1

SPECIMENS: 6 ♂ ♂, 3 ♀ ♀; 9 mi. ENE Sontecomapan, 0 feet, 15 Aug. 1962, 1 ♂: 0.5 mi. S Barrosa, 500 feet, 30 June 1962, 1 ♂: 2 mi. NE Catemaco, 1,100 feet, 26 July 1962, 1 ♂; 27 July 1962, 1 ♀; 12 Aug. 1962, 1 ♂: 2 mi. WSW Tapalapan, 1,600 feet, 20 Sept. 1962, 1 ♂: 2 mi. SSW Peak Volcán San Martín Tuxtla, 2,200 feet, 24 Aug. 1962, 1 ♂.

This species is common in Recently Abandoned Milpas, Pastures, and along Hedgerows throughout the Sierra. The butterflies have a relatively rapid flight that usually does not exceed three feet of the ground. The species is being described in McAlpine's forthcoming revision of the genus *Calephelis*. According to McAlpine (personal communication) the species is widely distributed in Mexico.

332. *Calephelis* sp. 2

SPECIMENS: 3 ♂♂, 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 26 July 1962, 1 ♂; 16 Sept. 1962, 1 ♂, 1 ♀; 8 mi. SSE Catemaco, 1,950 feet, 29 Sept. 1962, 1 ♂.

This species apparently is sympatric with the former but less common. Most butterflies were collected in Recently Abandoned Milpas, Pastures, and along Hedgerows. The species is being described by McAlpine in his forthcoming revision of the genus *Calephelis*, and who states (personal communication) that the species is known from Tabasco, Quintana Roo, and Yucatán. Thus, my specimens from the Sierra represent a new state record.

333. *Charis velutina* (Godman & Salvin)

SPECIMENS: 6 ♂♂; 800-1,900 feet; 27 Feb.-24 Oct.

*Charis velutina* is uncommon and found primarily along the borders of Hedgerows, Semi-Evergreen Seasonal Forest, Lower Montane Rain Forest and in the Deciduous Woodland and the *Pinus-Quercus* Associates. The flight is relatively rapid and close to the ground.

334. *Charis myrtea* (Godman & Salvin)

SPECIMENS: 9 ♂♂; 1,900 feet, 13 Nov.

This species is common but extremely local. All nine specimens were collected as they rested on the upper- and under-surfaces of leaves of an unidentified tall bush that was growing along the margin of a disturbed section of Semi-Evergreen Seasonal Forest on Cerro Cintepec.

335. *Charis psaros* (Godman & Salvin)

SPECIMEN: 1 ♂; 1.5 mi. NNW Ocotil Chico, 2,700 feet, 15 June 1965.

*Charis psaros* is rare. The single specimen was collected along a sunlit trail within the *Liquidambar-Quercus* Associates of the Montane Rain Forest.

336. *Charmona gynaea zama* (Bates)

SPECIMENS: 6 ♂♂, 2 ♀♀; 1,100-2,400 feet; 21 June-16 Nov.

This metalmark is locally common, being found mainly along

the margins of the Semi-Evergreen Seasonal Forest, the *Pinus-Quercus* Associates of the Deciduous Woodland, Montane Rain Forest, and Hedgerows.

337. *Baeotis hisbon zonata* Felder

SPECIMENS: 3 ♀ ♀; 1,800, 1,900 feet; 29 May-25 Oct.

All three specimens of this rare species were collected as they fed on the blossoms of *Calliandra grandiflora* in the *Pinus-Quercus* Associates of the Deciduous Woodland.

338. *Lymnas pixe pixe* Boisduval

SPECIMENS: 4 ♂ ♂, 8 ♀ ♀; 500-1,800 feet; 20 June-10 Aug.

This riodinid is locally common and found principally along the margins of the Semi-Evergreen Seasonal Forest and Hedgerows. Most butterflies were collected on cloudy days.

339. *Mesene margaretta* (White)

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 26 Sept. 1962.

The single individual was collected as it fed on the white flowers of the composite *Bidens pilosa* var. *bimucronata* in a Recently Abandoned Milpa bordering Lago Catemaco.

340. *Mesene croceola* Bates

SPECIMENS: 7 ♂ ♂, 11 ♀ ♀; 1,100-2,300 feet; 22 Feb.-30 Oct.

This species is locally common and seasonal. Most specimens were collected in the fall within the *Pinus-Quercus* Associates of the Deciduous Woodland as they fed on the blossoms of *Calliandra grandiflora* and as they rested on the undersurfaces of the leaves of *Quercus conspersa*. The species probably is colonial for rarely was a single butterfly seen alone.

341. *Symphachia rubina* Bates

SPECIMENS: 2 ♀ ♀; Ocotul Chico, 1,900 feet, 9 July 1963, 1 ♀; 8 mi. SSE Catemaco, 1,900 feet, 13 Nov. 1962, 1 ♀.

This metalmark is rare. One female was collected as it fed on the blossoms of *Heliotropium indicum*—a plant that is common around the houses of the Popoluca Indians—and the other as it rested on the undersurface of a leaf in a Recently Abandoned Milpa.

342. *Symphachia accusatrix* Westwood

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 30 Aug. 1963.

The single specimen was collected as it rested on the undersurface of a leaf of an unidentified shrub along the margin of a section of Semi-Evergreen Seasonal Forest.

343. *Symphachia tricolor hedemanni* (Felder)



SPECIMENS: 3 ♂♂ ; 2,100, 2,700 feet; 5 May, 24 Oct.

This species is uncommon and restricted to the *Pinus-Quercus* Associates of the Deciduous Woodland. All butterflies were collected as they fed on the flowers of *Calliandra grandiflora*.

344. *Phaenochitonias sagaris tyriotes* (Godman & Salvin)

SPECIMENS: 2 ♂♂ ; 2 mi. SW Sontecomapan, 900 feet, 12 July 1962, 1 ♂ : Ocotil Chico, 1,900 feet, 11 Feb. 1965, 1 ♂.

This riodinid is rare. One butterfly was collected as it flew through a Recently Abandoned Milpa and the other as it rested on the undersurface of a leaf in a shrubby area within the *Pinus-Quercus* Associates of the Deciduous Woodland.

345. *Anteros carausius carausius* Westwood

SPECIMENS: 5 ♂♂ , 3 ♀♀ ; 1,100-2,600 feet; 12 March-23 Oct.

Although uncommon, this species is found in a variety of habitats—margins of Hedgerows, the Semi-Evergreen Seasonal Forest, and the Lower Montane Rain Forest. Unlike most other species of riodinid, the butterflies of *A. c. carausius* very seldom hold their wings in a horizontal position.

346. *Calydna venusta* Godman & Salvin

SPECIMENS: 1 ♂ , 1 ♀ ; 0.5 mi. S Barrosa, 500 feet, 30 June 1962, 1 ♀ : 2 mi. NE Catemaco, 1,100 feet, 4 Oct. 1962, 1 ♂.

Both specimens of this rare species were collected along the margins of Semi-Evergreen Seasonal Forest. *Calydna venusta* has not been recorded from Veracruz. The nearest recorded locale is Oaxaca (Godman & Salvin, 1879-1901).

347. *Emesis liodes* Godman & Salvin

SPECIMENS: 6 ♂♂ , 3 ♀♀ ; 1,100 feet; 28 June-7 Sept.

*Emesis liodes* is uncommon and extremely local. All nine specimens were collected as they rested on the undersurfaces of leaves along the margins of and just within a small section of Semi-Evergreen Seasonal Forest bordering Lago Catemaco. The flight is rapid and erratic.

348. *Emesis mandana mandana* (Cramer)

SPECIMENS: 1 ♂ , 4 ♀♀ ; 500-2,600 feet; 12 March- 23 Sept.

This riodinid is uncommon and found primarily along the margins of Hedgerows and the Semi-Evergreen Seasonal Forest. Most butterflies were collected as they fed on the blossoms of *Cordia spinescens*.

349. *Emesis tenedia* Felder

SPECIMENS: 1 ♂ , 7 ♀♀ ; 1,100-2,450 feet; 14 June-18 Aug.

Although *E. tenedia* is uncommon, the species nevertheless is the most common member of the genus within the Sierra.

The butterflies were collected in a variety of habitats—along the margins of Hedgerows and the Semi-Evergreen Seasonal Forest, and in Recently Abandoned Milpas and grassy areas in the *Pinus-Quercus* Associates of the Deciduous Woodland. The behavior is similar to that of most members of the family.

350. *Emesis lupina* Godman & Salvin

SPECIMENS: 3 ♂♂, 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 29 July 1962, 1 ♀; 28 Sept. 1962, 1 ♂; 30 Sept. 1962, 2 ♂♂.

All specimens of this uncommon species were collected along the margins of small patches of Semi-Evergreen Seasonal Forest bordering Lago Catemaco. Hoffmann (1940) records the species only from the valley of the Río Balsas (Guerrero). Therefore, my specimens from the Sierra represent a new state record.

351. *Tharops menander isthmiae* Godman & Salvin

SPECIMENS: 6 ♂♂, 1 ♀; 1,100 feet; 1 July-12 Aug.

This species is local and uncommon. All specimens were collected in a small pasture bordered by small patches of Semi-Evergreen Seasonal Forest. The butterflies are attracted to the blossoms of *Lantana camara*.

352. *Thisbe irenea belides* Stichel

SPECIMENS: 1 ♂, 1 ♀; 1 mi. SE Sontecomapan, 700 feet, 14 July 1962, 1 ♂; 2 mi. SW Sontecomapan, 900 feet, 24 July 1962, 1 ♀.

This riodinid is rare. Both specimens were collected along the borders of Lower Montane Rain Forest.

353. *Polystichtis sudio* (Hewitson)

SPECIMENS: 5 ♂♂, 7 ♀♀; Ocotal Grande, 1,800 feet, 15 May 1965, 2 ♂♂; 1,900 feet, 19 June 1963, 2 ♀♀; 1 mi. NNE Ocotal Chico, 2,000 feet, 31 May 1965, 1 ♂; 2,100 feet, 14 June 1963, 1 ♀; 2 mi. N Ocotal Chico, 2,800 feet, 3 Aug. 1963, 1 ♀; 2,900 feet, 26 July 1963, 1 ♀; 3 mi. NNW Ocotal Chico, 3,550 feet, 1 ♀; 2 mi. NNW Ocotal Chico, 3,800 feet, 13 April 1965, 2 ♂♂, 1 ♀.

This dimorphic species is locally common and found primarily in the *Liquidambar-Quercus* Associates of the Montane Rain Forest and the Montane Rain Forest on the Santa Marta massif. The butterflies were collected most frequently as they rested on the undersurfaces of leaves and on the trunks of gum trees. The flight of the male is very rapid, erratic, and usually above eight feet of the ground. The flight of the female usually is considerably slower and nearer the ground than that of the male. On several occasions I mistook females for specimens of

*Dismorphia fortunata* (Pieridae: Dismorphiinae) and for one of the transparent species of ithomiids.

354. *Anatole agave* (Godman & Salvin)

SPECIMEN: 1 ♂; 2 mi. NE Catemaco, 1,100 feet, 18 Nov. 1962.

The single male was collected as it flew about one foot above the ground in a Pasture bordering Lago Catemaco. The flight of this species is not as rapid and erratic as most members of the family.

355. *Anatole rossi* Clench

SPECIMENS: 61 ♂ ♂, 32 ♀ ♀; 1.25 mi. E. Mecayapan, 1,025 feet, 1 Aug. 1963, 1 ♂: 0.25 mi. SSE Ocotál Chico, 1,700 feet, 8 June 1963, 2 ♀ ♀: 0.5 mi. SSE Ocotál Chico, 1,800 feet, 23 June 1963, 1 ♂; 25 July 1963, 1 ♂; 26 July 1963, 1 ♂: 1 mi. S Ocotál Chico, 1,800 feet, 7 June 1963, 2 ♂ ♂: 0.25 mi. E Ocotál Grande, 1,800 feet, 19 June 1963, 1 ♀: 1 mi. SSE Ocotál Chico, 1,800 feet, 23 Oct. 1962, 1 ♂: Ocotál Chico, 1,800 feet, 8 June 1963, 4 ♀ ♀; 4 Aug. 1963, 1 ♂; 1,900 feet, 7 June 1963, 2 ♂ ♂, 2 ♀ ♀; 13 July 1965, 26 ♂ ♂, 5 ♀ ♀: 1 mi. E Ocotál Grande, 1,850 feet, 8 Aug. 1963, 1 ♂: 0.25 mi. E Ocotál Chico, 1,900 feet, 9 June 1963, 3 ♂ ♂, 2 ♀ ♀: Ocotál Grande, 1,900 feet, 19 June 1963, 1 ♂; 4 July 1963, 1 ♂: 0.25 mi. SE Ocotál Chico, 1,950 feet, 1 Aug. 1963, 1 ♂: 0.25 mi. SE Ocozotepec, 1,950 feet, 1 Aug. 1963; 6 ♀ ♀: 0.25 mi. ESE Ocozotepec, 1,950 feet, 1 Aug. 1963, 3 ♂ ♂ (of which 1 is the holotype): Ocozotepec, 2,000 feet, 1 Aug. 1963, 3 ♂ ♂, 4 ♀ ♀: 0.25 mi. N Ocotál Chico, 2,100 feet, 11 June 1963, 3 ♂ ♂; 15 June 1963, 1 ♂; 18 June 1963, 1 ♀: 1.25 mi. N Ocotál Chico, 2,200 feet, 26 July 1963, 1 ♀: 1 mi. N Ocotál Grande, 2,300 feet, 15 May 1965, 5 ♂ ♂; 2 June 1965, 1 ♂: 1.25 mi. NE Ocotál Chico, 2,600 feet, 16 June 1963, 1 ♂; 2,700 feet, 16 June 1963, 1 ♀. (All specimens collected in 1962 and 1963, except the one holotype, are paratypes—see Clench, 1964).

This metalmark, which is described in Clench (1964), is locally abundant throughout the *Pinus-Quercus* Associates of the Deciduous Woodland. The butterflies occur in small colonies only on many of the pine covered ridges in the immediate vicinities of the Popolucan villages of Ocotál Chico, Ocotál Grande, and Ocozotepec. The immature stages (of which most are myrmecophilous) and the life history of this endemic species have been described (Ross, 1964c, 1966). The larval food plant is *Croton repens*.

356. *Peplia lamis molpe* (Hübner)

SPECIMENS: 11 ♂ ♂, 8 ♀ ♀; 150-2,400 feet; 15 May-18 Nov.

This species is common in most open, shrubby areas throughout the Sierra irrespective of plant formation. Most butterflies were collected as they visited flowers, particularly those of *Vismia mexicana*, and as they rested on the undersurfaces of leaves.

357. *Nymula calice mycone* (Hewitson)

SPECIMEN: 1 ♂; Ocotal Chico, 1,900 feet, 5 Feb. 1965.

The single male of this species was collected along the margin of a section of Semi-Evergreen Seasonal Forest on the Santa Marta massif.

358. *Calociasma lilina* (Butler)

SPECIMEN: 1 ♂; 0.5 mi. S Barrosa, 500 feet, 30 June 1962.

This riordinid is rare. The single specimen was collected as it rested on the undersurface of a leaf along the margin of a small section of Semi-Evergreen Seasonal Forest.

TRIBE Theopini

359. *Theope eleutho* Godman & Salvin n. ssp.

SPECIMENS: 2 ♂ ♂, 1 ♀; 2 mi. NE Catemaco, 1,100 feet, 3 Aug. 1962, 1 ♂; 7 Sept. 1962, 1 ♀; Ocotal Chico, 1,900 feet, 4 July 1963, 1 ♂.

This species is uncommon and found both in pastures and the *Pinus-Quercus* Associates of the Deciduous Woodland. The specimens were collected as they fed on the blossoms of *Cordia spinescens*. Clench (personal communication) states that the specimens from the Sierra probably represent a new subspecies. The nearest recorded locale for *T. eleutho* is Panamá (Godman & Salvin, 1879-1901).

## VI. CORRELATION AND SYNTHESIS

### Biotic Relationships

#### LIFE ZONES

Merriam (1892) in his original life zone classification unfortunately dealt only superficially with areas south of the United States. His broad "Tropical Region" included the entire Sierra de Tuxtla. However, several other authors—Goldman (1920, 1951), Dickey and van Rossen (1938), and Lowery and Dalquest (1951)—working in various localities in Mexico and

Central America, have found it necessary within their respective study areas to subdivide this "Tropical Region." The resulting divisions or zones, as with nearly all of the life zones in North America, originally were defined and delineated using plants, mammals, and birds as indicator species. Lately, however, several workers (see Garth and Tilden, 1963) have recognized that insects—especially butterflies with their fixed larval food plants, their relatively high mobility potential, and their migratory habits—may, with some justification, be ranked below plants but before mammals and birds in order of decreasing reliability as zonal indicators.

Andrle (1964) was the first to attempt a zonal analysis of the Sierra de Tuxtla. His avifaunal and mammalian faunal investigations indicated that no distinct life zone boundaries existed but that only vaguely defined zones (if indeed they could be termed zones) were evident. He recognized two major zones: a Humid Tropical Zone (divisible into an Upper Subzone and a Lower Subzone) and an Arid Tropical Zone (nondivisible).

In order to determine if the 359 species of butterflies in the Sierra can be grouped according to Andrle's classification, to one of the others proposed for other areas of Mexico, or, indeed, to any pattern at all, I have compiled a list of butterfly species that are associated with each plant formation (Table II). The butterfly species are divided into two categories. First, are "indicator species"—those species that are found exclusively within the formation regardless of relative abundance. For the most part these species are in the Lycaenidae and Riodinidae, the members of which are notoriously flighty and evasive. Thus, additional collecting probably will remove many of these from the list. Second, are "characteristic species"—those species that are found commonly within the formation but not confined to it.

An analysis of the data in Table II indicates that all of the formations below 2,500 to 3,000 feet are rather similar regarding characteristic butterfly species. Likewise, those formations above approximately 3,000 feet are rather similar but quite distinct from those at lower elevations. Indeed, of the 39 species listed as occurring in the high altitude formations (Elfin Woodland, Montane Thicket, and Montane Rain Forest), only nine (23%) occur commonly in formations at lower elevations. Thus, a major division in butterfly fauna apparently does exist within the Sierra—a division separating the lower formations from the upper ones (the *Liquidambar-Quercus* Associates of the Montane Rain Forest serving as a transitional zone or ecotone).



TABLE II  
PLANT FORMATIONS AND ASSOCIATED BUTTERFLIES  
IN THE SIERRA DE TUXTLA

(When only one or two specimens were collected, these numbers appear in parentheses.)

1. Elfin Woodland

INDICATOR SPECIES

<i>Pedaliodes pisonia circumducta</i>	<i>Callophrys nr. longula</i> (1)
<i>Dione moneta poeyii</i>	<i>Callophrys a. agricolor</i> (1)
<i>Hypanartia dione</i>	<i>Thecla laothoe</i> (1)

*Celastrina argiolus gozora*

CHARACTERISTIC SPECIES

<i>Graphium c. calliste</i>	<i>Morpho polyphemus luna</i>
<i>Papilio androgeus epidaureus</i>	<i>Heliconius hortense</i>
<i>Dismorphia euryope</i>	<i>Vanessa virginiensis</i>
<i>Dismorphia nemesis</i>	<i>Limenitis leuceria</i>
<i>Dismorphia jethys</i>	<i>Anaea proserpina</i>
<i>Greta anetta</i>	<i>Eumaeus debora</i>
<i>Dioriste tauropolis</i>	<i>Euselasia cheles aurantiaca</i>
<i>Morpho theseus justiciae</i>	

2. Montane Thicket

INDICATOR SPECIES

<i>Oleria zea</i>	<i>Prepona brooksiana</i> (1)
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*Epiphile plutonia*

CHARACTERISTIC SPECIES

<i>Graphium c. calliste</i>	<i>Heliconius hortense</i>
<i>Ithomia leila</i>	<i>Limenitis leuceria</i>
<i>Greta anetta</i>	<i>Anaea proserpina</i>
<i>Dioriste tauropolis</i>	<i>Eumaeus debora</i>
<i>Morpho theseus justiciae</i>	<i>Euselasia cheles aurantiaca</i>
<i>Morpho polyphemus luna</i>	

3. Montane Rain Forest

INDICATOR SPECIES

<i>Thecla politus</i> (1)	<i>Thecla dodava</i> (1)
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CHARACTERISTIC SPECIES

<i>Parides photinus</i>	<i>Morpho polyphemus luna</i>
<i>Ithomia leila</i>	<i>Heliconius sapho leuce</i>
<i>Oleria paula</i>	<i>Heliconius hortense</i>
<i>Dircenna klugi</i>	<i>Limenitis leuceria</i>
<i>Episcada artena</i>	<i>Eumaeus debora</i>
<i>Greta anetta</i>	<i>Thecla plusios</i>
<i>Taygetes andromeda</i>	<i>Mesosemia gaudiolus</i>
<i>Caligo uranus</i>	<i>Polystichtis sudias</i>
<i>Morpho theseus justiciae</i>	

4. *Liquidambar-Quercus* Associates of the Montane Rain Forest  
(Ecotone)

INDICATOR SPECIES

<i>Calycopis pisis</i> (2)	<i>Peropthalma tullius lasius</i> (1)
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*Thecla thales* (2)*Charis psaros* (1)*Thecla tarpa* (2)

## CHARACTERISTIC SPECIES

*Dismorphia fortunata**Caligo memnon**Eurema albul**Morpho peleides montezuma**Eurema dina westwoodi**Heliconius cleobaea zorcaon**Ithomia leila**Heliconius ismenius telchinia**Oleria paula**Heliconius sapho leuce**Dircenna klugi**Heliconius petiveranus**Episcada artena**Heliconius charitonius**Pteronymia cottyto**vazquezae**Taygetes andromeda**Calycopis beon**Euptychia hesione**Strymon yojoa**Euptychia themis**Euselasia hieronymi**Euptychia disaffecta**Polystichtis sudias**Euptychia hermes sosybius**Peplia lamis molpe*

## 5. Lower Montane Rain Forest

## INDICATOR SPECIES

*Hyposcada v. virginiana**Eryphanis aesacus* (2)*Heliconius sara veraepacis* (1)*Thecla minthe**Phyciodes clara* (1)*Thecla tera* (1)*Polygonia g-argenteum* (2)*Thecla coronata* (1)*Catagramma lyca**Euselasia cataleuca**Catagramma casta* (1)*Thisbe irenea belides* (2)*Limenitis oberthuri* (2)

## CHARACTERISTIC SPECIES

*Parides photinus**Euptychia undina**Parides iphidamas**Euptychia hermes sosybius**Parides arcas mylotes**Euptychia libye**Dismorphia fortunata**Caligo memnon**Dismorphia praxinoe**Caligo uranus**Itaballia pisonis kicaha**Morpho peleides montezuma**Itaballia v. viardi**Heliconius cleobaea zorcaon**Melinaea lilis imitata**Heliconius ismenius telchinia**Mechanitis polymnia lycidice**Heliconius doris transiens**Mechanitis egaensis doryssus**Heliconius sapho leuce**Mechanitis menapis saturata**Heliconius petiveranus**Hypothyris lycaste dionaea**Heliconius charitonius**Napeogenes tolosa**vazquezae**Ithomia patilla**Phyciodes phillyra**Oleria paula**Biblis hyperia aganisa**Aeria pacifica**Pyrrhogyra otolais neis**Dircenna klugi**Diaethria anna*

*Episcada artena*  
*Pteronymia cottyto*  
*Greta oto*  
*Greta nero*  
*Pierella luna heracles*  
*Taygetes andromeda*  
*Taygetes keneza*  
*Euptychia hesione*  
*Euptychia metaleuca*  
*Euptychia themis*  
*Euptychia labe*

*Dynamine mylitta*  
*Dynamine dyonis*  
*Hamadryas februa gudula*  
*Hamadryas g. guatemalena*  
*Limenitis iphicla*  
*Limenitis paraeca*  
*Anaea electra*  
*Calycopis beon*  
*Strymon yojoa*  
*Thecla marysας damo*

#### 6. Semi-Evergreen Seasonal Forest

##### INDICATOR SPECIES

*Euptychia nr. alcinoe*  
*Epiphile adrasta bandusia*  
*Nessaea aglaura*  
*Myscelia rogenhoferi* (1)  
*Chlorippe cherubina* (1)  
*Anaea artacaena* (1)  
*Calycopis trebula*  
*Strymon albata* (2)  
*Thecla inachus carpophora* (2)  
*Thecla lisus* (2)  
*Thecla jebus* (1)  
*Thecla mulucha* (1)

*Euselasia sergia* (2)  
*Euselasia pusilla* (2)  
*Euselasia eubule* (1)  
*Hades noctula*  
*Nothome eumeus diadema* (1)  
*Charis myrtea*  
*Symmachia accusatrix* (1)  
*Calydna venusta* (2)  
*Emesis liodes*  
*Emesis lupina*  
*Nymula calice mycone* (1)  
*Calociasma lilina* (1)

##### CHARACTERISTIC SPECIES

*Graphium belesis*  
*Parides p. polyzelus*  
*Dismorphia fortunata*  
*Eurema albula*  
*Eurema dina westwoodi*  
*Melinaea lilis imitata*  
*Mechanitis polymnia lycidice*  
*Mechanitis egaensis doryssus*  
*Mechanitis menapis saturata*  
*Hypothyris lycaste dionaea*  
*Ithomia patilla*  
*Oleria paula*  
*Dircenna klugi*  
*Episcada artena*  
*Pteronymia cottyto*  
*Greta nero*  
*Greta oto*

*Caligo memnon*  
*Morpho peleides montezuma*  
*Heliconius cleobaea zorcaon*  
*Heliconius ismenius telchinia*  
*Heliconius doris transiens*  
*Heliconius petiveranus*  
*Heliconius charitonius vazquezae*  
*Chlosyne janais*  
*Biblis hyperia aganisa*  
*Pyrrhogyra otolais neis*  
*Diaethria anna*  
*Dynamine mylitta*  
*Dynamine dyonis*  
*Hamadryas februa gudula*  
*Hamadryas ferronia farinulenta*  
*Hamadryas g. guatemalena*

<i>Pierella luna heracles</i>	<i>Limenitis iphicle</i>
<i>Taygetes andromeda</i>	<i>Limenitis paraeca</i>
<i>Taygetes keneza</i>	<i>Anaea aidea</i>
<i>Euptychia hesione</i>	<i>Anaea electra</i>
<i>Euptychia mollina</i>	<i>Calycopis beon</i>
<i>Euptychia labe</i>	<i>Strymon yojoa</i>
<i>Euptychia themis</i>	<i>Heterosmaitia palegon</i>
<i>Euptychia undina</i>	<i>Thecla marsyas damo</i>
<i>Euptychia hermes sosybius</i>	<i>Mesosemia tetrica</i>
<i>Euptychia libye</i>	<i>Lymnas p. pixe</i>

7. *Bursera-Sabal-Orbignya* Associates of the Semi-Evergreen  
Seasonal Forest

INDICATOR SPECIES

*Itaballia demophile calydonia*    *Calycopis* sp. "C"

CHARACTERISTIC SPECIES

The same as those for the Semi-Evergreen Seasonal Forest.

8. Savanna

INDICATOR SPECIES

None.

CHARACTERISTIC SPECIES

<i>Papilio thoas autocles</i>	<i>Hamadryas g. guatemalena</i>
<i>Phoebis sennae marcellina</i>	<i>Marpesia chiron</i>
<i>Phoebis agarithe maxima</i>	<i>Limenitis iphicla</i>
<i>Eurema lisa</i>	<i>Limenitis paraeca</i>
<i>Eurema nise nelphe</i>	<i>Libytheana carinenta mexicana</i>
<i>Euptychia gemma freemani</i>	<i>Calycopis beon</i>
<i>Euptychia mollina</i>	<i>Strymon yojoa</i>
<i>Euptychia hermes sosybius</i>	<i>Thecla brescia</i>
<i>Actinote guatemalena</i>	<i>Hemiargus ceraunus zachaeina</i>
<i>veraacruzis</i>	<i>Hemiargus huntingtoni</i>
<i>Thessalia t. theona</i>	<i>hannoides</i>
<i>Junonia evarete</i>	<i>Everes comyntas</i>
<i>Mestra amymone</i>	<i>Leptotes cassius striata</i>
<i>Hamadryas februa gudula</i>	<i>Peplia lamis molpe</i>

9. Deciduous Woodland

INDICATOR SPECIES

*Eunica alcmena*    *Thecla maeonis* (1)

*Strymon serapio*

CHARACTERISTIC SPECIES

All of those in the Savanna in addition to *Mesene croceola*.

## NOTICES

**ADDRESS CHANGE:** After April 1, 1977, the address of the Journal will be: Santa Barbara Museum of Natural History, 2559 Puesta Del Sol Road, Santa Barbara, CA 93105.

**PUBLICATIONS:** Moths of Southern Africa. E. C. G. Pinhey, Tafelberg Publishers Ltd., 28 Wale St., Cape Town, South Africa. Available in U. S. A. from Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, CA 90007. \$35.95.

Butterflies of West Malaysia and Singapore, Vol. 1 and 2. W. A. Fleming, E. W. Classey Limited, Park Road, Faringdon, Berkshire, England. Available in U. S. A. from E. R. S. (above). \$47.00 set.

**ADDITIONAL PUBLICATIONS:** Revised Catalogue of the African Sphingidae (Lepidoptera) with Descriptions of the East African Species. R. H. Carcasson, E. W. Classey Ltd., Park Road, Faringdon, Oxon. SN7 7DR, England. Available in North America from Entomological Reprint Specialists, P. O. Box 77971, Dockweiler Station, Los Angeles, CA 90007. \$11.95.

**SPECIAL NOTICE:** The Smithsonian Foreign Currency Program, a national research grants program, offers opportunities for support of research in many countries in (among others) Systematic and Environmental Biology. Awards are determined on the basis of competitive scientific review. The deadline for submission is November 1 annually. For further information write the Foreign Currency Program, Office of International Programs, Smithsonian Institution, Washington, D. C. 20560.

**ADDRESS CORRECTION:** Kurt Johnson, author of "Post Pleistocene Environments and Montane Butterfly Relicts on the Western Great Plains" in volume 14, number 4 of the Journal: Dept. of Biology, City University of New York, City College, Convent Ave. and 138th Street, New York, NY 10031.

**DEFECTIVE COPIES:** Some missing pages have been detected in volume 14, number 4. Please check your copy; correct copies will be sent to those who received faulty issues and indicate such to us.

**WRITING CONTEST:** For articles on any entomological subject, to be published in Insect World Digest, a bimonthly magazine. The deadline for submission of articles is September 1, 1977. For detailed information, write to the editor, Dr. Ross H. Arnett, Jr., P. O. Box 505, Kinderhook, NY 12105.

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